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AMERICAN CHEMICAL SOCIETY.

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COMMITTEE ON PAPERS AND PUBLICATIONS:

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The Journal of the American Chemical Society appears monthly, except during July and August. It will contain all papers read before the Society, as well as abstracts from American and Foreign Journals, and a list of American Patents relating to Chemical Industries.

The Price of Subscription is $5.00 per year, in advance.

The Meeting Room and Library of the Society are at the University Building, Washington Square, New York.

The Regular Monthly Meeting is held on the first Friday of every month, at 8 P. M.

Corresponding Secretary:

A. C. HALE, 551 Putnam Ave., Brooklyn, N. Y.

Treasurer:

F. T. KING, 91 Columbia Heights, Brooklyn, N. Y.

Members can have access to the Library during the Summer months from 10 to 5, on presenting to the Janitor of the University Building a card, which can be obtained of the Librarian.

Back numbers of the Journal are sold to Members at $3.00, to others at $5.00, per volume. Apply to the Librarian

WILLIAM RUPP, 117 Pearl St., New York.

The Committee on Papers and Publications respectfully call attention to the resolutions of the Society, requiring that papers be submitted to the Committee before being read.

Authors will be furnished, gratis, with 20 reprints of each article published in the Journal, if application for the same be made when the article is sent.

Members are requested to give notice of any change of address, or failure in the delivery of the Journal. All communications relating to the Journal should be addressed to the Editor.

A. A. BRENEMAN, 97 Water St., New York.

Vice-President Breneman in the chair.

The minutes of the meetings of May 12th and 16th were read and accepted.

Mr. Chas. A. Catlin of the Rumford Chemical Works, Providence, R. I., and Mr. Ernest J. Lederle, Ph. B., of Stapleton, S. I., were elected as members, and D. F. Lucas, M. D., of Brooklyn, was elected as associate member.

The following were proposed as members: Chas. A. Pitkin, A. M., Ph. D., College of Physicians and Surgeons, Boston, Mass.; Geo. W. Patterson, Torpedo Station, Newport, R. I.; Major W. R. Livermore, Engineering Corps, U. S. A., Newport, R. I.; Lewis H. Laudy, Ph. D., School of Mines, New York.

Drs. Hale and Kent and Mr. Geisler were appointed as a committee to open and count the ballots on the revision of the Constitution received by the Corresponding Secretary.

Dr. Hale announced the result as follows: Seventy-three ballots had been received, two of which were thrown out as irregular.

Of the 71 regular ballots, 50 were for the new Constitution, 16 for the new Constitution without the fellowship clauses, and five against the Constitution.

The chair therefore declared the new Constitution accepted, as presented, by a clear majority vote.

A committee of three, consisting of Dr. Hale, Mr. McKenna and Mr. Geisler was appointed to ascertain the sense of the Society upon the question of holding an annual dinner, and was instructed to report at the October meeting.

The resignation of Mr. J. I. Holly was read and accepted.

Upon a motion of Dr. Munsell, the Board of Directors were empowered, at their discretion, to call a meeting of the Society in August or September in some city other than New York.

Dr. Waller read a paper "On the Determination of Lithia in Mineral Waters," after which the meeting was adjourned.

CHAS. F. McKENNA,
Recording Secretary.

REVISED CONSTITUTION OF THE AMERICAN CHEMICAL SOCIETY.*

ARTICLE I.

NAME.

This Society shall be known as the AMERICAN CHEMICAL SOCIETY.

ARTICLE II.

OBJECTS.

The objects of the Society shall be the advancement of Chemistry and the promotion of chemical research.

ARTICLE III.

MEMBERSHIP.

Section 1. The Society shall consist of Members, Associates, Fellows and Honorary Members.

Section 2. Any person who has conducted an original scientific research in chemistry, and published the result thereof, or who has received a degree in chemistry from an institution of repute, or who has taught chemistry in such an institution, or who has been engaged as a chemist in technical pursuits, shall be eligible for membership.

Section 3. Students of chemistry and all others interested in the objects which the Society seeks to promote, shall be eligible for election as Associates. Associates shall have all the privileges of members, except the rights of voting, holding office or serving on committees.

Section 4. Any member in good standing who has contributed an original article to the Journal of the Society shall be eligible for election as a Fellow.

Section 5. Past Presidents shall be *ex-officio* Fellows so long as they remain connected with the Society.

Section 6. Candidates for fellowship, not Past Presidents, shall be elected only by a majority vote of the Board of Directors, after

*Adopted June 6, 1890.

the presentation of their names to the Board, endorsed by ten members of the Society, not more than three of whom shall be Directors.

Section 7. Any member, not in arrears, paying at any one time the sum of one hundred dollars into the treasury of the Society, as commutation for dues, shall become a Life Member and shall be exempt from the further payment of annual dues.

ARTICLE IV.

OFFICERS.

Section 1. The officers of the Society shall be elected annually. They shall be

A President,
Six Vice-Presidents,
A Corresponding Secretary,
A Recording Secretary,
A Treasurer,
A Librarian,
Three Curators,

and a Board of thirteen Directors.

Section 2. The Board of Directors shall consist of the President, the three local Vice-Presidents, the Corresponding Secretary, the Recording Secretary, the Treasurer and six other members or Fellows of the Society. Any of the other officers may be members of the Board of Directors, if elected as such at the annual meeting.

ARTICLE V.

ADVISORY COUNCIL.

At the first annual meeting after the adoption of this Article there shall be elected twelve members of the Society, not more than three of whom shall reside within fifty miles of the City of New York, who, together with the President of the Society and the Chairmen of Local Sections, shall constitute an Advisory Council.

Of the twelve members of the Council first elected four shall be elected to serve for one year, four for two years and four for

three years, and after the annual meeting at which the Council is first elected four members shall be elected at each annual meeting to serve for three years to replace those members whose terms of office expire.

The Council shall be consulted in framing amendments to the Constitution or By-Laws, in the selection of places for the holding of general meetings, and in the expenditure of money from the General Fund, whenever such expenditure shall exceed five hundred dollars for any one purpose, and shall act as an advisory body in all matters affecting the general policy of the Society. Advice or suggestions offered by members of the Council upon any measures which come within their province shall be formally presented at the meeting of the Board of Directors, or of the Society, as the case may be, before action is taken upon such measures.

The President of the Society shall be President of the Advisory Council, *ex-officio*.

ARTICLE VI.

STANDING COMMITTEES.

There shall be

1. A Committee on Nominations for membership, consisting of five members ;

2. A Committee on Papers and Publications, consisting of three members.

ARTICLE VII.

MEETINGS.

Section 1. The annual meeting for the election of officers and committees shall be held in the month of December in each year, at the headquarters of the Society, and a majority of the votes cast shall be necessary for an election.

Section 2. General meetings may be held elsewhere at the pleasure of the Society.

ARTICLE VIII.

VOTING.

At the annual meeting of the Society and in voting for amendments to the Constitution and By-Laws, any absent member may

vote by a ballot subscribed with his own name, or may give authority in writing to any member to act as his proxy in voting.

ARTICLE IX.

HEADQUARTERS.

The headquarters of the Society shall be in the City of New York, and ten members shall constitute a quorum.

ARTICLE X.

LOCAL SECTIONS.

Local Sections of the Society, may be established by the Board of Directors on the receipt of a written request to that effect signed by ten members of the Society in good standing and not residing within fifty miles of the City of New York.

Such Sections may appoint their own local officers and committees, and may make any rules for their government not inconsistent with the Constitution and By-Laws of the Society. They may receive for local uses a share of their annual dues to the Society as provided in Art. XI.

The chairman of each Local Section shall be, *ex-officio*, a member of the Advisory Council.

Any Local Section may be dissolved by the Board of Directors.

ARTICLE XI.

FINANCES.

Section 1. All moneys received as annual dues of resident or subscription members shall be applicable as follows:

Two-thirds to the publication of the Journal and the general operating expenses of the Society.

One-third, or so much thereof as may be desired, in payment of rent or for other local uses.

Section 2. Any moneys from the above sources, not required for the Journal or for the general operating expenses and all surplus moneys not otherwise provided for shall be invested by the Board of Directors for the benefit of the Society within one year. Moneys so invested shall constitute the General Fund of the Society, and shall be so designated.

Section 3. Donations and bequests of money may be received, and expended or invested as hereinbefore provided, at the discretion of the respective governing bodies.

Section 4. All interest accruing from the invested funds of the Society may be reinvested or expended for the publication of the Journal, or for the general operating expenses of the Society, provided, however, that all interest, other than that derived from life memberships, as well as the General Fund, may be devoted, in whole or in part, to any special object, as determined by a majority of ballots cast in a general vote of the Society.

Section 5. All moneys received for life membership shall be invested as soon as possible and shall constitute a trust fund, to be known as the "Life Membership Fund," which shall be held in perpetuity to guarantee the future interests of such life members. The interest of said fund may, however, be employed in the publication of the Journal, but for no other purpose.

Section 6. All investments of the funds of the Society shall be made only in registered United States Government Bonds.

Section 7. All the provisions of Sections 1 and 2 of this Article shall apply equally to the Society and to all Local Sections.

ARTICLE XII.

AMENDMENTS TO THE CONSTITUTION.

Amendments to the Constitution shall be presented by the Board of Directors to the Society, upon the request of fifteen members, at the next regular meeting after the receipt of such request.

A copy of the proposed amendment shall be mailed within ten days thereafter to the address of each member. The amendment or amendments shall be voted upon at the following regular meeting. The assent of two-thirds of the members voting upon an amendment shall be necessary to its adoption.

ON BLAST FURNACE SLAGS AND THE FUSIBILITY OF SILICATES.

By Auguste J. Rossi.

Blast furnace slags are, with pig iron, the ultimate products of the reduction of the charges, their composition depending on the proportion of the different earthy elements contained in the ashes of coal, in the limestone and the ores, at least, of such elements as can form fusible compounds. As such, they are the real criterion by which a skillful manager will judge of the economical running of his furnace.

In general, other things being equal, the composition of the slags directly affects their fusibility and bears a close relation to the grade of iron obtained. Certain conditions corresponding to a comparatively low temperature in the furnace require also a very fusible slag and a readily fusible iron. Within certain limits, to be mentioned later, such a temperature may be sufficient to melt slags of a somewhat different composition, and that slag which requires the fusion of the least quantity of foreign matters, will be, obviously, the most economical and advantageous. Works on metallurgy contain many analyses of slags, often of little value, because neither the composition of the materials charged, their relative proportion, nor the character of the resulting pig metal are mentioned. There is no way of deducing—from the composition of the slag—its economy under given conditions. A blast furnace is as much a chemical apparatus as any that is used. Chemical laws govern the reactions which take place in it and metallurgists often find in practice that the composition of slags calculated from known charges, agree almost as closely as duplicate analyses. It is very desirable that all analyses of slags published should be accompanied by the data pertaining to each case. The writer has collected the analyses of a great number of slags from European and American furnaces, many made by himself; with most of them he has been able to ascertain the accompanying conditions, and in all the general conditions and the character at least

of the pig metal run with them are known. It has seemed to him that some information on a subject so important for iron workers would be of interest.

The works of Berthier, Caron, Ebelmen, Percy and others, on the fusibility of silicates, have been precious contributions to this question, but they are not generally well known to those who would find them most useful, owing perhaps to the preconceived idea that they are too technical. It is intended to quote from them practical data exclusively, showing, by a few examples, that the conclusions which these metallurgists have reached are fully corroborated by blast furnace practice. The present paper will be limited to the subject of fusibility of silicates so far as connected with their composition, with economy of working and character of pig metal. Many circumstances may modify results sometimes foreseen, and to say that a slag of a certain composition and fusibility will invariably correspond to a stated grade of iron is impossible. Still, it will be found that divergences, when well marked and decided, can generally be traced to certain special or abnormal conditions.

The determination of the empirical or rational formula of a silicate presents no difficulty to the technical chemist, but it involves a kind of knowledge which many iron masters, otherwise thoroughly competent, do not always have at command. Slags are complex silicates, principally of alumina, lime and magnesia, but contain also, and normally, notable percentages of ferrous and manganous oxide, potash, soda and baryta, amounting to as much as 7 and 8 per cent. The presence of these elements in quantities which cannot be neglected in ascertaining the type of a silicate, still further complicates the calculations. The composition of a slag, the percentage of its constituents, rarely affords, at first sight, a clear conception of its chemical character. A comparison with others, if it can be easily made, may be of great advantage. Given the percentage of silica and of the different bases, by a simple calculation and a table given below, without the use of any *chemical symbol or formula*, the character of a slag, its approximation to a certain chemical type, can be ascertained at once. The method is given in full.

Blast furnace slag is a combination of silica with various bases, principally alumina, magnesia and lime. The ores of iron contain, as gangue, silica associated with certain earthy or alkaline bases and almost invariably an excess of free silica as quartz. Should such an ore be smelted without any addition of fluxes, the free silica, not finding a base, would combine with a part of the oxide of iron which it would remove as slag. This is what takes place in the Catalan forge, where the slag is obtained at the sacrifice of a certain quantity of iron. Fluxes are then added in the form of limestone or dolomitic limestone, of which as little should be used as is consistent with the proper fusibility of the silicate formed from the silica of the ores and the ash of the coal with the bases found in the latter and in the limestone.

Owing to the complexity of the silicates as compounds, the theory of them is still obscure and, in the following, we do not pretend to deal with theoretical considerations, but only with slags as they appear in books on metallurgy and as they are practically known to ironmasters.

In the composition of slags as given in these works, up to a comparatively recent date, the symbol SiO_3 is used for silica, which was for a long time regarded as a "trioxide." The *equivalent* of silicon was then taken at 22.00 by some, at 21.25 by others; it is now assumed to be 14.00; at. wt. Si = 28.00. The equivalent of silica, SiO_3, was consequently taken as 46.00 or 45.25 as the case might be, that of SiO_2 is now 30, mol. wt. 60. The oxygen of silica calculated from the old formula SiO_3 was then: $\frac{24}{45 \cdot 25} = 0.530$ or $: \frac{24}{46} = 0.522$. It is now $\frac{8}{15} = 0.533$. In the same manner the *equivalents* of lime, magnesia and alumina, as late as 1865, were slightly different from what they are assumed to be now, that of lime being taken at 28.25, which is now 28.00; at. wt. 56. All these differences affect only the hundredths of the composition as given in these books. SiO_2 will be used here for silica, unless otherwise mentioned. All the formulæ of slags are expressed in *equivalents*, (and not in the atomic weights) in all books up to 1886 and even later, and this practice will be followed here. Whatever may be said logically of the consideration of silicates as derivatives of certain hypothetical radicals, the use of the equiv-

alents has, in this case, the advantage of representing clearly to the eye a certain relation of silica to bases, and of the oxygen of the acid to the oxygen of the bases, corresponding, in general, to a certain grade of iron. The different earths not only saturate different quantities of silica according to their equivalents, but, for the same base, the proportions of the basic element to that of the acid may vary. The result of all observations shows that compound as well as simple bodies combine together in a certain number of proportions distinctly determined, which are generally to each other in simple ratio, at least when we deal with natural minerals. For instance, 1, 2, 3 of lime, magnesia or, in general, of such other oxides of symbol RO, will combine with the same quantity 1 of silica or conversely: so also will alumina or isomorphous oxides, R_2O_3, though in different proportions. Blast furnaces slags considered as silicates of protoxide may be: acid, neutral, sesquibasic, bibasic or, occasionally, tribasic. Sesquiacid slags correspond to "types" in which there is respectively: 1 of base to 2 of acid (acid); 1 of base to 1 of acid (neutral); $1\frac{1}{2}$ of base to 1 of acid, or, 3 of base to 2 of acid (sesquibasic); 2 of base to 1 of acid (bibasic); 3 of base to 1 of acid (tribasic); 1 of base to $1\frac{1}{2}$ of acid or 2 of base to 3 of acid (sesquiacid). Their formulæ are

$RO,2SiO_2$ RO,SiO_2 $3RO,2SiO_2$ $2RO,SiO_2$ $3RO,SiO_2$ $2RO,3SiO_2$

Acid, neutral, sesquibasic, bibasic, tribasic and sesquiacid and the ratio of oxygen of the silica to that of the base is respectively for each :

4:1 2:1 4:3 1:1 2:3 6:2 or 3:1

Many other silicates fall between these types and are met with in slags. To form a neutral silicate, that is one in which the oxygen of the acid is double that of the base, the bases of the formula R_2O_3, require 3 atoms of acid. Hence, the neutral silicates in R_2O_3 take the form R_2O_3, $3SiO_2$; the acid silicates, 1 base to 2 of acid, will be represented then by R_2O_3, $6SiO_2$, the sesquibasic, $1\frac{1}{2}$ base to 1 acid, by $1\frac{1}{2}R_2O_3$, $3SiO_2$, or, $3R_2O_3$, $6SiO_2$, or, R_2O_3, $2SiO_2$, and, indeed, oxygen of acid 4, oxygen base 3::4:3. In the same manner the bibasic silicate in R_2O_3 has for its formula: $2R_2O_3$, $3SiO_2$; the tribasic, R_2O_3, SiO_2; the sesquiacid: $2R_2O_3$, $3SiO_2$. If we insist on these points it is because these

formulæ are constantly met with in metallurgical books, in which slags are called by the preceding names. As we shall frequently find formulæ in which the silicates are expressed by SiO_3, we must be able readily to transform one formula expressed in SiO_2 into one in which SiO_3 is used, or conversely. For this, the following method will be found convenient:

RULE—To convert the formula in SiO_2 into the older formula in which silica is regarded as a trioxide: Multiply the *entire formula* by 3, correct the silica term by the equation $SiO_2 = \frac{2}{3}SiO_3$ and reduce the whole to its lowest terms. For instance, if to transform the formula, RO, $SiO_2 + R_2O_3$, $3SiO_2$ which represents a neutral silicate of RO and R_2O_3, we multiply by 3, we have:

$3RO,\ \underbrace{3SiO_2} + 3R_2O_3,\ \underbrace{9SiO_2}$; but since: $1SiO_2 = \frac{2}{3}SiO_3$; $3SiO_2 = 2SiO_3$

$= 2SiO_3 \qquad = 6SiO_3 \quad 9SiO_2 = 6SiO_3$, and the old formula would be, for the same compound: $3RO,\ 2SiO_3 + 3R_2O_3,\ 6SiO_3$ or, reduced, $3RO,\ 2SiO_3 + R_2O_3,\ 2SiO_3$.

Conversely: to change formula containing SiO_3 into one containing SiO_2, divide *all* terms by 3 and correct the silica term by $SiO_3 = \frac{3}{2}SiO_2$. We have put in Table I. the new and old formulæ for silicates of the same chemical character, giving also for each the oxygen ratio of bases in RO to oxygen of bases in R_2O_3 and the ratio of the total oxygen of the bases to that of the acid.

TABLE I.

NEW FORMULA: SiO_2. Corresponding to:	OLD FORMULA: SiO_3.
Equiv.... $SiO_2 = 14 + 16 = 30$ At. wts. ..... $= 28 + 32 = 60$ Oxygen Silica $= \frac{28}{60} = \frac{14}{30} = \frac{7}{15} = 0.533$ of SiO_2	Equiv..... $SiO_3 = 21.25 + 24 = 41.25$ Oxygen..... $SiO_3 = \frac{24}{21.25} = 0.5304$ of SiO_3
(A.)—*Acid Silicate.* 2 Equiv. acid to 1 base RO 6 " to 1 " R_2O_3 Oxygen ratio.....RO...R_2O_3..SiO_2 1 : 3 : 16 Formula.....RO, $2SiO_2 + R_2O_3$, $6SiO_2$ O of acid : O of bases :: 16 : 4 = 4 : 1 The disilicate of modern nomenclature derived from $H_2Si_2O_5 = H_2O$, $2SiO_2$; O ratio, 4 : 1.	(A).—*No corresponding name given by Percy.* Oxygen ratio.....RO — R_2O_3 SiO_3 3 : 3 24 or 1 : 1 : 8 Formula.....3RO, $4SiO_2 + R_2O_3$, $4SiO_2$ O of acid : O of bases : 24 : 6 = 4 : 1 In accordance with other names, based upon SiO_3, this would be a *quadrisilicate.*

TABLE I.—*Continued.*

NEW FORMULA : SiO_2,	Corresponding to :	OLD FORMULA : SiO_3.
(B.)—*Sesquiacid Silicate.* 1½ Eq. acid to 1 base RO or 3 " to 2 " RO 9 " to 2 " R_2O_3 O. ratio... ..RO...R_2O_3..SiO_2 2 : 6 : 24 or 1:3:12 Formula.....2RO, $3SiO_2 + 2R_2O_3$, $9SiO_2$ O of acid : O of bases :: 12 : 4 = 3 : 1 Trisilicate derived from $H_4Si_3O_8 = 2H_2O, 3SiO_2$ O ratio = 3 : 1		(B.)—*Neutral or Trisilicate of Percy.* O. ratio..... RO...R_2O_3.. SiO_3 1 : 3 : 12 Formula..... RO, $SiO_3 + R_2O_3$, $3SiO_3$ O of acid : O of bases :: 12 : 4 = 3 : 1
(C.)—*Neutral Silicate.* 1 Equiv. acid to 1 base RO 3 " to 1 " R_2O_3 O. ratio..... .....RO...$R_2O_3SiO_2$ 1 : 3 : 8 Formula.....RO, $SiO_2 + R_2O_3$, $3SiO_2$ O of acid : O of bases :: 8 : 4 = 2 : 1 The monosilicate of modern type derived from metasilicic acid $H_2SiO_3 = H_2O, SiO_2$ O ratio 2 : 1		(C.)—*Sesquibasic or Bisilicate of Percy.* O. ratio ....RO R_2O_3 SiO_3 3 : 3 : 12 or 1 : 1 : 4 Formula:. .....3RO, $2SiO_2 + R_2O_3$, $2SiO_2$ O of acid : O of bases :: 4 : 2 = 2 : 1
(D.)—*No Special Name.* 3 Eq. acid to 4 of base RO 9 " to 4 " R_2O_3 RO O. ratio .....4 : 12 : 24 or 1 : 3 : 6 Formula... .....4RO, $3SiO_2 + 4R_2O_3$, $9SiO_2$ O of acid : O of bases = 24 : 16 or 3 : 2 A trisilicate of modern type.		(D.)—*The Bibasic or Sesquisilicate of Percy.* O. ratio..... .. ..2 : 6 : 12 or 1 : 3 : 6 Formula.....2RO, $SiO_2 + 2R_2O_3$, $3SiO_2$ O of acid : O of bases :: 6 : 4 = 3 : 2
(E.)—*Sesquibasic Silicate.* 1 acid to 1½ base RO or 2 " to 3 " RO 6 acid to 3 base R_2O_3 O. ratio...3 : 3 : 8 or 2 " to 1 " R_2O_3 Formula .....3RO, $2SiO_2 + R_2O_3$, $2SiO_2$ O of acid : O of bases : 8 : 6 = 4 : 3 A disilicate of modern type derived from $H_6Si_2O_7 = 3(H_2O)\ 2SiO_2$. O ratio 4 : 3.		(E.)—*No special name by Percy.* O. ratio... .....RO R_2O_3 SiO_2 9 : 9 : 24 or 3 : 3 : 8 Formula.....9RO, $4SiO_2 + 3R_2O_3$, $4SiO_2$ O of acid : O of bases :: 24 : 18 = 8 : 6 = 4 : 3
(F.)—*Bibasic Silicate.* 1 acid to 2 base RO 3 " to 2 " R_2O_3 O. ratio...2 : 6 : 8 = 1 : 3 : 4 Formula..2RO, $SiO_2 + 2R_2O_3$, $3Si\ O_2$ O of acid : O of bases :: 4 : 4 = 1 : 1 The monosilicate, basic, of modern nomenclature, derived from orthosilicic acid $H_4SiO_4 = 2(H_2O)\ SiO_2$: O ratio 1 : 1		(F.)—*Tribasic or Monosilicate of Percy.* O. ratio..... ....3 : 3 : 6 or 1 : 1 : 2 Formula ....3RO, $SiO_3 + R_2O_3$ SiO_3 O of acid : O of bases :: 2 : 2 = 1 : 1.
(G.)—*Tribasic Silicate.* 1 acid to 3 base RO 3 " to 3 " R_2O_3 or 1 " to 1 " R_2O_3 O. ratio...3 : 3 : 4 Formula.3RO, $SiO_2 + R_2O_3$ SiO_2 O of acid : O of bases :: 4 : 6 = 2 : 3 The monosilicate, *parasilicate* of modern nomenclature, derived from $H_6SiO_5 = 3(H_2O)$ SiO_2, O ratio 2:3.		(G.)– *No special name by Percy.* O. ratio..... .. ..9 : 9 : 12 or 3 : 3 : 4 Formula .....9RO, $2SiO_2 + 3R_2O_3$. $2SiO_2$ O of acid : O of bases :: 12 : 18 = 4 : 6 = 2 : 3

It will be seen that the ratio of oxygen of acid to that of bases is *the same* in both formulæ, as it should be, since: $3SiO_2 = 2SiO_3$ as far as oxygen is concerned; and also as to total equivalent; $3SiO_2 = 90$, using present equivalents, or $2 \times \mathbf{45} = 90$, using the old equivalent assumed for silicon.

This ratio of oxygen of acid to oxygen of base is the most *characteristic feature of a type of silicates*, whatever may be said of their exact molecular composition. When it is found to be *the same* in two silicates containing different bases in different proportions it corresponds to the same calculated empirical formula for each, to the same saturation of bases and acid and the same fusibility, the conditions of temperature determining the production of such slags in a blast furnace are similar, in other words, they are likely to accompany the same grade of iron.

In a question of such importance as this, involving references to works in which notations and nomenclature are different from those now used, it is necessary to establish a clear basis of understanding.

Using the symbol SiO_3 for silica, Percy and others have called a *neutral silicate or trisilicate* a silicate in which the O of base: O of acid :: 1:3. Hence, RO, SiO_3 represented for him a trisilicate. Now such silicate, with SiO_2, corresponds to a *sesquiacid* silicate $2RO, 3SiO_2$; O of silica, 6: O of RO, 2 :: 3:1; the neutral silicate of our days being one in which O of acid $= 2 \times$ O of bases or RO SiO_2, silica being a *dioxide*, not a *trioxide*. In R_2O_3 this neutral silicate of Percy has the formula R_2O_3, $3SiO_3$ (O of silica, $9 = 3 \times 3$ times O of base). Now: $2R_2O_3$, $9SiO_2$ (O acid $18 =$ O base, 6×3).

In the same manner he called a *sesquibasic or bisilicate* a silicate in which O of acid $= 2 \times$ O of bases, $3RO, 2SiO_3$; $R_2O_3, 2SiO_3$; now: RO, $SiO_2 + R_2O_3$, $3SiO_2$ (neutral).

He called a *bibasic or sesquisilicate* a silicate in which O acid: O bases :: 3:2; 2RO, SiO_3, $2R_2O_3$, $3SiO_3$; O ratio; 3:2; 9:6=3:2. Now: $4RO, 3SiO_2 + 4R_2O_3, 9SiO_2$: O ratio; 6:4=3:2; 18:12=3:2, and does not correspond to any of the types under SiO_2 mentioned in the table I.

He called a *tribasic or monosilicate* a silicate in which O of acid = O of base, now called bibasic: 3RO, $SiO_3 + R_2O_3$, SiO_3; now: 2RO, $SiO_2 + 2R_2O_3$, $3SiO_2$.

In all that follows when the terms *acid*, *neutral*, etc., silicate are used, reference is made to silica expressed by the symbol SiO_2, and not by SiO_3, unless otherwise mentioned.

In the modern conception of the composition of the silicates, normal hydrated silicic acid has the formula $H_4SiO_4 (=2H_2O, SiO_2)$, a tetrabasic acid containing 4 atoms of hydrogen which can be replaced by metals. It has not been isolated, but it is probable that it exists in the pseudo-solutions coming from the dialysis of liquids containing alkaline silicates. The metasilicic hydrate is formed when solutions of dialyzed silicic hydrate are evaporated. It is probable that metasilicic acid can be condensed in the same way as metaphosphoric acid to form complex molecules of polysilicic acids. There are known: orthosilicates, $2RO, SiO_2$, corresponding to the normal hydrates (bibasic silicates of table I); monobasic silicates, RO, SiO_2 (neutral), which seems to be derived from metasilicic acid. The real molecular constitution of the polysilicates is ignored. In most of the formulæ one is satisfied to express the ratio of oxygen of silica to oxygen of bases. In the orthosilicates (bibasic) it is 1:1 in the metasilicates (neutral) 2:1; in the trisilicates (sesquiacid) 3:1, *e. g.*, or those, $2RO, 3SiO_2$. In basic silicates (serpentine type) 4:3 (sesquibasic). There are other basic silicates in which it is 3:2 (dysthene).*

Although no solid hydrate of silicic acid possessing a constant composition is known, we are acquainted with a large number of silicates forming many natural mineral species. "The hypothetical acids or hydrogen salts from which they are supposed to be derived are here given." "Molecular weights have been ascertained only for the volatile organic silicates or silicic ethers, the molecular weight of the other compounds is therefore doubtful; the oxygen ratio being the best criterion to classify them; their formulæ are represented by the simplest form possible." (Roscoe & Schorlemmer's Chemistry.)

Also, from another authority. "But scarcely any of the silicates are represented by formulæ which express their derivation from the acid. H_4SiO_4; or other hypothetical radicals. They are generally represented as combinations of metallic oxides with

* Frémy.

SiO_2" (Bloxam's chemistry). It is this mode of representation that we have adopted, using the equivalents and the formula SiO_2, for silica. In this manner the slag of composition, $6Ca_2SiO_4$, $Al_4(SiO_4)_3$, using atomic weights and derivation from hypothetical radicals, would be represented by the formula, $12CaO$; $2Al_2O_3$, $9SiO_2 = 6(2CaO,SiO_2) + 2Al_2O_3$, $3SiO_2$ (O of acid = O of bases), which, referring to Table I, represents what we may call a *bibasic silicate* with RO and R_2O_3, derived from the orthosilicic acid; $H_4SiO_4 = 2H_2O_3$, SiO_2. A monosilicate; orthosilicate according to modern nomenclature, (Table II). O of acid = O of bases. The tribasic or *monosilicate* of Percy, $3RO$, $SiO_3 + R_2O_3$, SiO_3 (O of acid = O of bases) (Table I).

TABLE II.

MONOSILICATES.

1° *Metasilicic acid:* $H_2SiO_3 = H_2O,SiO_2$, forming monosilicates (monobasic) O ratio 2:1 corresponding to RO,SiO_2 (neutral), Ex. Enstatite Mg, $SiO_3 = MgO$, SiO_2. Augite (Ca, Mg) $SiO_3 = O,2SiO_3$—Beryl. $\begin{matrix}Al_2\\Be_2\end{matrix}(SiO_3)3 = \begin{matrix}Al_2\\Be_2\end{matrix}\Big\} O_3 \quad 3SiO_2 \begin{matrix}Be_2\\Al_2\end{matrix}\Big\} O_3, 2SiO_3$. O ratio 2:1.

2° *Orthosilicic acid* $H_4SiO_4 = 2(H_2O)SiO_2$ forming bibasic monosilicates. O ratio 1:1 corresponding to $2RO,SiO_2$ (bibasic); $2R_2O_3,3SiO_2$—Ex: Olivine, $Mg_2,SiO_4 = 2MgO,SiO_2$; Phenakite, $Be_2SiO_4 = 2BeO$, SiO_2.

3° *Parasilicic acid* $= H_6SiO_5 = 3H_2O,SiO_2$; Oxygen ratio 2:3 forming monosilicates corresponding to: $3RO,SiO_2$ (tribasic, O ratio 2:3). Ex: Chondrodite $Mg_3,SiO_5 = 3MgO,SiO_2$; Andalusite, $Al_2SiO_5 = Al_2O_3,SiO_2$ (tribasic silicate) $= Al_2O_3\frac{2}{3}SiO_3 3Al_2,O_3\ 2SiO_3$ O ratio = 6:9 or 2:3 as before.

DISILICATES.

$H_2Si_2O_5 = H_2O,2SiO_2$ O ratio : 4 : 1 corresponding to RO, $2SiO_2$ (acid silicate) O ratio 4 : 1, Ex: Petalite

$$(Na,Li)Si_2O_5 = \begin{matrix}Na\\Li\end{matrix}\Big\} O,2SiO_2$$

$$= \underbrace{3RO,4SiO_3}_{\text{acid silicate,}} + \underbrace{4Al_2O_3 4SiO_3}$$

an acid silicate in SiO_3; O ratio 12 : 3 = 4 : 1.

$H_6Si_2O_7 = 3H_2O,2SiO_2$; O ratio 4 : 3 corresponding to 3RO, $2SiO_2$ (sesquibasic) Ex.: Serpentine, $Mg_3,Si_2O_7 = 3MgO, 2SiO_2$ $9MgO,4SiO_3$ (sesquibasic) O ratio 12 : 9 = 4 : 3.

$H_{10}Si_2O_9 = 5H_2O,2SiO_2$; O ratio 4 : 5 corresponding to 5RO, $2SiO_2$, Ex. Euclase $Al_2,Be_2,Si_2O_9 = \left.\begin{matrix}Al_2O_3\\2BeO\end{matrix}\right\} 2SiO_2$ or $\left.\begin{matrix}Al_2\\Be_2\end{matrix}\right\} O_5$, $2SiO_2$ O ratio 4 : 5.

TRISILICATES.

$H_4Si_3O_8 = 2(H_2O),3SiO_2$; O ratio 6 : 2 = 3 : 1 corresponding to 2RO, $3SiO_2$ (sesquiacid) Ex.: Orthoclase $Al_2K_2(S_3O_8)2 = (Al_2K_2)O_4,6SiO_2$ or $(Al_2K_2)O_8,12SiO_2 = 2(K_2O),3SiO_2 + 2R_2O_3,9SiO_2$: O ratio 6 : 2 = 18 : 6 = 3 : 1 = $KO,SiO_3 + Al_2O_3 3SiO_3$ O ratio 9 : 3 = 3 : 1 (sesquiacid).

$H_{15}Si_3O_{11} = 5(H_2O)3SiO_2$; O ratio 6 : 5 Ex.: Prehnite, $Al_2Ca_2Si_3O_{11} = \left.\begin{matrix}Al_2O_3\\2CaO\end{matrix}\right\} 3\ SiO_2$; O ratio 6 : 5.

$H_{14}Si_2O_{13} = 7(H_2O)3SiO_2$; O ratio 6 : 7 Ex.: Epidote, $Al_6Ca_4H_2(Si_2O_{13})_2$.

This mode of representation has the great advantage of showing at once the oxygen ratio which, certainly, the formulæ : $6Ca_2SiO_4$, $Al_4(SiO_4)_3$, and especially $Ca_{12}\ Al_4\ (SiO_4)_9$! ! ! do not *clearly* indicate as compared with : $6(2CaO,SiO_2) + 2Al_2O_3, 3SiO_2$ or even with $12CaO,2Al_2O_3,9SiO_2$.

The atomic weights of silicon, oxygen, aluminum, calcium, magnesium, iron, manganese, barium, the oxides of which are always present in variable quantities in a slag, entering into its composition wholly or in part, being *all double the equivalents* of these elements, the formulæ of silicates, considered as "combinations of metallic oxides with SiO_2," expressed either by using the *atomic weights or the equivalents, are then, in fact, exactly the same.* The terms monobasic or neutral, bibasic, tribasic of Table I. are based on the amount of *base* 1, 2, 3 as compared to *1 of acid ;* these silicates are really monosilicates, as in the more modern conception of Table II., in which, for 1 of silica, SiO_2, there may be 1, 2, 3 of base replacing 1, 2, 3 of H_2O of the hypothetical radical. The acid silicate of Table I., containing *2 of acid* for 1 of base, is, in the same manner, a "disilicate" of modern nomenclature (Table II.);

and, for the same amount of acid, 2, there may be 1, 3, 5 of base. Likewise, the sesquiacid silicate of Table I., containing 3 of acid for 2 of base, is the modern trisilicate of Table II.; and, for this quantity, 3 of SiO_2, there may be 2, 5 or 7 of base.

In the names used in Table I. the proportion of the *basic element* has been taken as a guide in giving the name to the compound; in Table II. it is the amount of the *acid element* which has given its name to the type of silicate. In both denominations the oxygen ratio remains the same as well as the proportion of silica to bases. The whole difference lies in considerations of a certain order which may satisfy the mind as implying the idea of logical derivations from hypothetical radicals, but practically there is none, as there should not be.

The ground being thus cleared of all possible confusion in the notation we have followed and shall follow, as best conforming with data furnished by books on metallurgy and best known amongst technical blast furnace managers, let us proceed with the subject proper.

Berthier and, after him, many others (Percy, Ebelmen, Caron), have designated respectively as

Very Fusible = Silicates melting completely to a liquid glass at the temperature of a porcelain kiln, no blast.

Little Fusible = Silicates melting at the temperature of fusion of wrought iron.

Fusible = Silicates melting at a white heat or above in a furnace having a forced blast.

Refractory = Silicates not fusible or melting imperfectly at a temperature above that of fusion of wrought iron.

It is not enough that a slag should melt when it reaches the zone of the tuyeres, in the blast furnace; it must not run pasty nor thicken: it must preserve a certain fluidity when it comes in contact with the air or the sides of the forepart of the crucible. The word "fusible" indicates then a limit which it is possible to reach, but beyond which it would not be safe to go except in extraordinary cases of pressure and temperature of blast. All the silicates intermediate between "very fusible" and up to "fusible," constitute really the admissible slags.

Fusibility of Silicates = The *silicates* of potash and soda are very fusible in almost all proportions.

Aluminium Silicate = This compound, the basis of all clays, is absolutely infusible at the highest temperature of a blast furnace. The silicate containing $73SiO_2$, 27Al, softens a little. 3% of potash or soda is enough to cause the aluminium silicate to soften considerably; such quantities are frequently met with in iron ores.

Calcium Silicates = Simple calcium silicates are not generally fusible; practically only *one* of them is really fusible in the blast furnace.

LIME.	SILICA.	
88.5%	11.5%	Refractory: nearly 25 RO, $3SiO_2$ or 8RO, SiO_2 O of acid $= \frac{8}{8} = \frac{1}{4}$ O of base.....Hectobasic.
78.0	22.0	Refractory: nearly 24 RO, $6SiO_2$ or 4RO, SiO_2 O of acid $= \frac{4}{4} = \frac{1}{2}$ O of base.....Quadribasic
70.3	29.7	Refractory: nearly 20 RO, $8SiO_2$ 5RO, $2SiO_2$ O of acid $= \frac{4}{5}$ O of base.....(Disilicate Table II.)
64.2	35.8	Little Fusible: 18 RO, $9SiO_2$ or 2 RO, SiO_2 O of acid $= \frac{2}{2} =$ O of base.Bibasic (Table I.), Monosilicate Orthosilicic (Table II.)
47.2	52.8	Fusible: 14 RO, $14SiO_2$ or RO, SiO_2 O of acid $= \frac{2}{1} = 2 \times$ O of base.....Neutral (Table I.)
37.8	62.2	Fusible: 10 RO, $8Sio_2$ or 5RO, $4SiO_2$ O of acid $= \frac{8}{5}$ O of base.....Metasilicate (Table II.)
24.4	75.6	Little fusible: 6.8RO, $20SiO_2$ or RO, $3SiO_2$ O of acid $= \frac{6}{1} = 6$ O of base..Triacid (Trisilicates, Table II.)

And we see from these experiments of Berthier, that the more *basic* the silicate becomes the *less* fusible it is, the neutral silicates being more fusible than the bibasic, and the latter more fusible than the quadri—and hectobasic. We see also that *beyond a certain limit of acidity* the refractory properties increase.

Magnesium Silicates.

MAGNESIA.	SILICA.	
72.2%	27.8%	Refractory: 28.80 MgO, 7.40SiO_2, nearly 4 RO, SiO_2; O of acid $= \frac{8}{4} = \frac{1}{2}$ O of base. Quadribasic (Table I.)
56.5	43.5	Refractory: 22.60 MgO, 11.50 SiO_2, nearly 2RO SiO_2; O of acid $= \frac{2}{2} =$ O of base. Bibasic (Table I.)

MAGNESIA.	SILICA.	
40.1	59.9	Little fusible: 16MgO, 16SiO_2, nearly RO, SiO_2 O of acid $= \frac{2}{1} = 2$ O of base. Neutral (Table I.)
30.0	70.0	Little fusible: 12 MgO, 18SiO_2, nearly 2RO, SiO_2; O of acid $= \frac{6}{3} = 4$ O base. Sequibasic (Table I.)

And again, though none are "fusible" the *less* basic the silicate the *less* infusible it is.

Double and Multiple Silicates.

The compound silicates are enormously more fusible than any single silicate, not even excepting the alkaline silicates. They melt at a temperature much inferior to the average of the temperatures of fusion of the simple silicates composing them, this temperature being frequently *lower* than that corresponding to the fusion point of *the most fusible*, as in certain alloys, indicating, in a multiple silicate, a normal chemical combination. Lime, which forms with silica, alumina, and magnesia, but one refractory or practically infusible compound of which the simple silicates are absolutely refractory, furnish double silicates which fuse readily.

LIME.	MAGNESIA.	SILICA.	
17.3%	25.0%	57.5%	Very fusible: 5 (CaO, SiO_2) × 10 (MgO, SiO_2) Neutral Silicate; O of acid : O of bases : : 2 : 1
33.5	12.1	54.4	Very fusible: 4.84 (MgO,SiO_2) × 9.60 (RO, SiO_2) Neutral Silicate; O of acid : O of bases : : 2 : 1
25.0	30.0	45.0	Very fusible: 12 MgO, 7.50 SiO_2, approximating 3RO,2SiO_2 (Sesquibasic); O of acid, O of bases 4 : 3
19.8	14.0	06.2	Fusible: approximating 2RO,3SiO_2 (Sesquiacid); O of acid : O of bases 3 : 1
9.3	20.3	70.4	Fusible: approximating 4RO,7SiO_2; O of acid : O of bases 2 : 2 $3\frac{1}{2}$: 1
21.2	7.7	71.1	Fusible: nearly RO,2SiO_2 (Acid); O of acid O of bases 37 : 9.15 4 : 1
20.9	15.8	73.3	Fusible: approx. 2RO,3Sio_2----2RO,3SiO_2 (Sesquiacid); O of acid : O of base 39 : 12.50 nearly 3 : 1

Moreover we see that the *Sesquibasic* silicates are less fusible than the *Neutral*, and again, when the silicate goes beyond a certain "acidity" it becomes less fusible.

LIME.	ALUMINA.	SILICA.	
26.1%	15.7%	58.2%,	Very Fusible : 7.50 CaO,7.50SiO_2 + 2.50 R_2O_3, 7.50SiO_2 = RO,SiO_2 + R_2O_3, 3SiO_2, (Neutral) 2 : 1.
34.0	16.0	50.0	Very fusible : 2.13R_2O_3, 6.15SiO_2 + 7,45RO, 7.20SiC_2, nearly RO,SiO_2 + R_2O_3,3SiO_2, (Neutral) 2 : 1.
26,0	31.3	43.7	Very fusible : 7.40RO, 3.70SiO_2 + 4.86R_2, O_3 7.95SiO_2, nearly 2RO, SiO_2 + 2R_3O_2 3SiO_2, (Bibasic) 1 : 1.
36.8	22.0	41.0	Very fusible : approximating 2RO,SiO_2 + 2R_2 O_3, 3SiO_2 (Bibasic) 1 : 1.
47.3	14.2	38.4	Fusible : Exactly..2RO SiO_2 + 2R_2 O_3 3SiO_2, (Bibasic) 1 : 1.
46.3	27.8	25.9	Fusible: 13.23RO, 3.35SiO_2 + 441R_2O_3, 3.45 SiO_2, approximating 4RO, SiO_2 + 4 R_2O_3, 3SiO_2, (Quadribasic) 1 : 2.
20.2	12.1	67.7	Fusible: 5.77RO, 8.65SiO_2 approxim. 6RO, 9SiO_2 or 2RO, 3SiO_2 + 2R_2O_3 9SiO_2, (Sesqui acid), 36.10 : 11.42 = 3 : 1.
10.5	19.0	70.5	Fusible: 5.77RO, 8.65SiO_2 approxim. 6RO, 9SiO_2 or 2RO, 3SiO_2 + 2R_2O_3 8SiO_2 (Sesqui acid), 37.60 : 11.80 = 3 : 1.

And again, the *Neutral* slags and slags approximating the *bibasic* are more fusible than the exactly *basic or quadribasic slags* or those in which the acidity is beyond a certain limit, as the silicates are less basic the more fusible they become.

In certain cases, however, silica is not alone sufficient to saturate the oxides; according to ordinary laws, it has been observed that certain slags were *fusible*. It has been admitted that alumina in those circumstances can perform the functions of an acid. This is corroborated by the experiments of Berthier, who found that in the proportions given below some aluminates were fusible.

ALUMINA.	LIME.	MAGNESIA.	
19.9%	56.5%	23.6%,	Little fusible : 6 CaO, 3MgO, Al_2O_3.
49.9	32.3	14.8	Fusible : 6CaO, 3MgO, $4Al_2O_3$.
47.0	33.8	19.2	Fusible : 4CaO, 3MgO, $3Al_2O_3$.

We find such compounds in nature : Spinel, MgO,Al_2O_3 is fusible in the blast furnace, and certain slags containing only from 23 to 25% of silica and a large quantity of alumina have been run in English furnaces.

MAGNESIA.	ALUMINA.	SILICA.		OX. RATIO.
29.3%	24.8%	45.9%,	Very fusible: $4RO,3SiO_2$ + $4R_2O_3$, SiO_2 (Bibasic of *Percy*)	24 : 16 3 : 2.
20.0	17.0	63.0	Very fusible : 8RO, 8.40 SiO_2 or approxim. RO,SiO_2 + R_2O_3 $3SiO_2$ (Neutral)	33.6 : 16, or nearly 2 : 1.

Looking over these tables, the results of many experiments by Percy, Caron, Berthier, etc.,* we find that of the compounds which SiO_2 can form with lime and alumina, or alumina and magnesia, or magnesia and lime, as a general rule, the *less basic they are the more fusible they become* until a certain *limit of acidity* is reached, and that amongst them, when the quantity of silica is *above 40% and not above 60%*, the compound becomes as much more fusible as the percentage of silica is above the first figure, varying between 40 and 60, beyond which last limit the silicate appears to fuse again with more difficulty.

In replacing in a double silicate any weight whatsoever of one of the bases by an equivalent weight of a third, a still more fusible compound is *invariably* obtained. The more complex the silicate, the more fusible and more fluid it becomes. If we consider that oxide of manganese, ferrous oxide and alkalies are always met with in slags in proportions which may reach 5 to 7%, that the alkalies, in very small quantities, increase considerably the fusibility of even the most refractory silicates, it can be better understood why unjudicious charges in limestone do not necessarily produce injurious ef-

* Quoted in Vathaire *Les Haus Fourneaux.*

fects. A slag, for instance, which, if based upon a certain per cent. of alumina and lime would have been somewhat refractory and might have become the cause of serious trouble, acquires a greater *fusibility* and *fluidity* owing to the presence of manganous and ferrous oxides, alkalies and magnesia, derived from the limestone. Magnesia was for many years considered as a detrimental element, tending to produce infusibility! Had the iron master been aware of the conditions of fusibility of his slag and of the influence of the elements entering into its composition, affecting the said fusibility, he might have been able to reduce notably the charges in limestone, thus saving on first cost, on burden of furnace and on coal consumed, and gained at the same time in fluidity.

Within certain limits, the *more basic* the silicate *the less fusible* it is as a rule, meaning by basic not only the *number of bases* but also the *total quantity* of the basic element as compared with that of silica. The pig metal will also have more tendency to be gray as the slag is less fusible and to be white if the latter melts readily. The reason of this is found in the fact that the pig metal separates from the gangue which surrounds it only when the latter melts. If the gangue melts in the boshes at a comparatively low temperature the pig metal will pass to the hearth without stopping, reaching the crucible without having been exposed to the high temperature of the zone around the tuyeres and without having charged itself with carbon or silicon ; carbon being more soluble in cast iron as the temperature of the latter is higher, and silicon being produced only by the contact of silica and iron carbides at high temperatures.

The same observations regarding the fusibility of the silicates as connected with the proportion of silica to bases apply to triple and multiple silicates as well as to double. Berthier has even remarked that, in the triple silicates of alumina, magnesia and lime, these compounds are much more fusible, as the ratio of the quantity of lime and magnesia to that of alumina approximates 3 : 1.

As an example of the fusibility of multiple silicates, according to their composition, many analyses of slags that the writer has had occasion to make in the course of his practice might be quoted. Three are here given :

1° Slag run with *white iron and a little mottled;* furnace, 40 ft. high; hot blast at 650° to 700° F.; pressure of blast, 3½ lbs. per square inch; ores, magnetites; temperature, comparatively low in the furnace.

SiO^2	48.35	
Al_2O_3	12.74	
MgO	10.71	
CaO	24.83	
Alkalies	1.01	38.76
MnO	0.63	
FeO	1.58	

Silica is above 40%, nearly 50%. Bases in RO, 38.76% = nearly three times the alumina. 12.74% × 3 = 37.22%. Oxygen of silica : 25.98 : 18.49 oxygen of bases :: 24 : 18, nearly or 4 : 3. A sesquibasic silicate but a little *less basic.*

Exact ratio: 4.49 : 3.08. A good corroboration of the remarks of Berthier. Formula: 3RO, $2SiO_2 + R_2O_3SiO_2$, approximately.

2° Slag run with *gray iron No. 2;* furnace, 60 feet high; blast, 850° to 900° Fahr.; pressure, 7½ lbs. per square inch; temperature in furnace much higher; slag *less fusible:*

SiO_2	= 40.45	
Al_2O_3	= 8.90	
MgO	= 15.65	
CaO	28.80	
MnO	3.01	49.61
FeO	1.00	
Alkalies	1.15	

Silica is about at the limit, 40%; bases RO = nearly 6 times bases R_2O_3. O of acid, 21.57 : O of bases, 19.80 :: 1.09 : 1 : approximating a bibasic slag. 2RO, $SiO_2 + 2R_2O_3$, $3SiO_2O$, ratio 1 : 1. The pig iron was gray No. 2. Slag *bibasic, less fusible,* according to the observation of Berthier, than the preceding.

3° *Slag run in the same furnace* with a change in the charges. Ores, magnetites and hematites containing 7 to 8% manganese oxide, fuel, coke and anthracite.

SiO_2	= 32.65	
Al^2O^3	= 23.00	
CaO	31.00	
MgO	0.00	
FeO	2.00	37.20
MnO	4.20	

Silica much below 40%. Bases in RO = 1½ times bases in R_2O_3. O of acid, 17.41 : O of bases 20.94 :: 1 : 1.20 : more basic than a bibasic silicate, 1 : 1.

Formula of slag: 10.23RO, $4.35SiO_2$ = 4.35 (2.35RO, SiO_2) *less* basic than a tribasic slag, *3RO, SiO_2,* but *more basic* than a *bibasic* : 2RO, SiO_2. Slag more basic than the preceding, consequently *less* fusible. Iron, Scotch gray No. 1, graphitic iron, kish cinder.

It seems, at least, to be established from the direct experiments of metallurgists, corroborated by blast furnace practice, that,

whatever may be the relation between the fusibility of slags and the grades of iron for simple, double or multiple silicates, the more *basic the type of* the slag the less fusible it is, as a rule.

In calculating a silicate, the saturation of the different bases for silica to produce the same type has to be taken in consideration. Considering only the principal constituents of a slag, lime, magnesia and alumina, it will readily be seen that to form an *acid slag* (Table I.) RO, $2SiO_2 + R_2O_3 6SiO_2$:

Acid Slag { 1 Alumina will saturate 3.495 SiO_2.
1 CaO " 3.000 "
1 MgO " 2.143 "

And in the same manner it can be calculated that to form a neutral or a sesquibasic slag, the saturations will be as follows:

TABLE III.

Acid Slag.	Sesquiacid Slag.	Neutral (Monobasic).
RO, $2SiO_2 + R_2O_3$, $6SiO_2$	2RO, $3SiO_2 + 2R_2O_3$, $9SiO_2$	RO, $SiO_2 + R_2O_3$, $3SiO_2$
1 Al_2O_3 will take....3.495 SiO_2	1Al_2O_3 will take.....2.6213 SiO_2	1Al_2O_3 will take... 1.7475 SiO_2
1MgO " .3.000 "	1MgO " .....2.2222 "	1MgO " ....1.5000 "
1CaO " .2.143 "	1CaO " .....1.6071 "	1CaO " ....1.0714 "
Sesquibasic Slag.	**Bibasic Slag.**	**Tribasic Slag.**
3RO, $2SiO_2 + R_2O_3$, $2SiO_2$	2RO, $SiO_2 + 2R_2O_3$, $3SiO_2$	3RO, $SiO_2 + R_2O_3$, SiO_2
1Al_2O_3 will take....1.165 SiO_2	1Al_2O_3 will take.....0.8738 SiO_2	1Al_2O_3 will take....0.5825 SiO_2
1MgO " ....1.000 "	1MgO " .....0.7500 "	1MgO " ....0.5000 "
1CaO " ...0.F14 "	1CaO " .....0.5378 "	1CaO " ....0.3571 "

Hence, 1 lb. of alumina, as far as saturation for silica is concerned, is equivalent, respectively, to

$$\frac{3.495}{3.143} = \frac{2.6213}{1.6071} = \frac{1.7475}{1.0714} = \frac{1.165}{0.714} = \frac{0.8738}{0.5378} = \frac{0.5825}{0.3571}$$

or to 1.631 lbs. CaO, *whatever may be the type of the silicate;* and for the bases in R_2O_3, in general, in proportion to 1.631, as is the equivalent of one particular base of this formula to the equivalent of Al_2O_3. As to the bases in RO, requiring 1 equiv. of silica, for 1 equivalent of base to form a neutral silicate, *their equivalence* in lime is directly proportional to *their chemical equivalents.*

Hence we can calculate the following table, and say, *as far as saturation of base for silica is concerned and whatever be the type or the character of a silicate:*

TABLE III (A).

1 lb. Al_2O_3	= 1.631	CaO
1 lb. MgO	= 1.400	"
1 lb. FeO	= 0.780	"
1 lb. MnO	= 0.780	"
1 lb. KO	= 0.590	"
1 lb. NaO	= 0.900	"
1 lb. Fe_2O_3	= 1.125	"
1 lb. BaO	= 0.365	"

A glance at the above figures show *a priori*, and apart from the question of the beneficial effect that lime may have in a blast furnace in eliminating certain injurious elements of the ores, the inconsistency of using lime in excess as flux. It is, of all the principal fluxing bases of the rocks and ores, the most expensive as to cost, and the one of which the greatest quantity is required.

More of it is necessary than of magnesia or alumina to saturate, to a certain type, a given amount of SiO_2. The table shows why a *dolomite* is preferable to a *calcite*, each pound of magnesia contained in it being really equivalent to 1.40 lbs. lime, and, moreover, the double or triple silicate into which magnesia enters is much more fusible; and yet for years dolomitic limestones have been systematically rejected or sparingly used for fear "of inducing infusibility of the slag."

Suppose certain charges to have been so calculated that alumina, lime and magnesia were in proportion to silica within the figures given above: that is, 1 lb. of alumina for every 3.495 lbs. SiO_2, 1 lb. MgO for every 3 lbs. of SiO_2, 1 lb. CaO for every 2.143 lbs. of SiO_2, etc. (acid silicate, Table III.). We arrive then at the following composition for slags of the different types:

TABLE IV.

Composition.	Acid.	Sesquiacid.	Neutral.	Sesquibasic.	Bibasic.	Tribasic.
SiO_2	73.45	67.36	58.04	47.95	40.85	31.52
Al_2O_3	7.00	8.56	10.98	13.71	15.58	18.04
MgO	8.15	10.10	12.89	15.97	18.15	21.01
CaO	11.40	13.97	18.08	22.37	25.41	29.42
	100.00	100.00	100.00	100.00	100.00	100.00

Or, taking slag of the neutral type, its composition, as taken from the preceding (Table III.) will be:

SiO_2	58.04
MgO	12.89
CaO	18.08
Al_2O_3	10.97
	99.98

Such a slag, according to what has been seen above, and to the remarks of Berthier, ought to be a very fusible slag. First: It is a *neutral* slag, not very basic, consequently, silica is above 40 per cent., nearing the limit of 60 per cent. Bases in RO = 30.97 = nearly 3×10.97, the bases in R_2O_3. Its formula is RO, $SiO_2 + R_2O_3 3\,SiO_2$. The iron run with it ought to be white or at least of a very light grade of gray. These deductions made, *a priori,* from its composition, from a study of the fusibility of silicates, find their verification in the actual results obtained in a blast furnace in England. This hypothetical slag is identical, as far *as type* is concerned, with one actually run in conditions indicating plainly a low temperature in the furnace, *i. e.*, a very fusible silicate. If, by proportioning properly the charges so as to obtain it, it were found to be more economical in use than those of the English slag, the two types being alike, all the probabilities would be—the conditions of running of the furnace being the same—that the same grade of iron would be obtained, but, in one case, much more economically than in the other.

Percy gives the following analysis of the slag of a charcoal furnace. Working as *white pig* with a little of *light mottled*—consequently of a slag run at a low temperature.

SiO_2 = 54.00
MgO ... 0.57
CaO ... 25.67
Al_2O_3 .. 13.04
FeO 2.44
MnO ... 2.20

If the formula of this slag were calculated it would be found to represent exactly, to the second decimal, a *typical neutral slag.*

Its formula is: 2.02 R_2O_3, 5.97 SiO_2 + 8.60 RO, 8.50 SiO_2 of (R_2O_3, 2.96 SiO_2) 2.02 + 8.00 (1.01 RO, SiO_2) *i. e.*, nearly as possible R_2O_3, 3 SiO_2 + RO SiO_2 :

O of acid : O of bases : : 2 : 1; type neutral, and of the two slags, the typical one would have been obtained *at the least expense*, since, while containing about the same amount of alumina, 10.97 per cent against 13.04, and silica 54 against 58.04, it contains only 18 per cent of lime, as against nearly 26 per cent. in the other, or 50 per cent. less. A *dolomitic* limestone would have readily furnished the 13.04 per cent. MgO without using the *excess* of *pure calcite* with only 0.57 MgO which were necessary to obtain the 25.67, CaO required to make up for the deficiency of bases.

The formula gives of course, the means of comparing these two slags but for the determination of the oxygen of the compound a knowledge of the symbols and equivalents is absolutely necessary, a glance at the two analyses not furnishing sufficient indication as to the similitude in chemical type of the two compounds. We see in this case that silica is about the same: 54 and 58%, that *the total* proportion of bases is 42.00 in one case, against 43.92% in the English slag; but, in the typical slag, we find 18% of lime and nearly 13% of magnesia, while the English slag contains more lime, nearly 50% more, and *no* magnesia, and the apparant coinsidence of quantity of silica and *total* quantity of basic elements cannot be taken as a criterion owing to the different saturation of the bases for SiO_2. It can hardly be said that the two compounds are of *somewhat* the same nature, certainly they do not seem to be *identical* in type as they really are, nor could it be said that one had been obtained with a much greater economy than the other. No deductions can be drawn from their composition except through a study of their formulæ. Suppose that in the hypothetical slag a certain quantity of magnesia (8%) were replaced by a *proportionate quantity of lime* according to the equivalents of these two bases, which express also, in this case,

their *saturation for* SiO_2 ; also that a quantity of 10% of alumina were replaced by the equivalent proportion of lime according to saturation of this latter base for SiO_2, as explained above ; that is, at the rate of 1.631 lime for 1 of alumina and 1.40 lime for 1 of magnesia. It is clear that the silicate has preserved its character, its type, the *saturation of SiO_2 by the bases remaining the same*, but its composition is considerably changed.

We have left 4.89% of magnesia, 0.97 alumina and 18.08 lime, and then making the calculation we have :

			Hypothetical Slag.	English Slag.
SiO_2 58.04	SiO_2 58.0		SiO_2 53.01	54.00
MgO 4.89	MgO 4.89	or reducing	MgO 4.47	0.57
Al_2O_3 0.97	or Al_2O_3 0.97	to	per ct. Al_2O_3 0.88	13.04
$8MgO = 8 \times 1.40 = 11.20CaO$	CaO 45.97		CaO 41.66	25.67
$10Al_2O_3 = 1.631 \times 10 = 16.31CaO$	109.49		100.00	....

If we compare this composition with that of the English slag we find that the two analyses are quite different, and still they represent two silicates of the same type, likely to be found in a furnace under the same conditions of temperature and iron.

If, for the sake of illustration, we replace in the original typical slag, 8% of magnesia and 18 of lime by their equivalents in *alumina for saturation of silica* we have the composition :

			Hypothetical Slag.	English Slag.
SiO_2 58.04		SiO_2	63.16	SiO_2 54.00
MgO 4.89	or reducing	MgO	5.32	MgO 0.57
CaO 0.08	to	CaO	0.09	CaO 25.07
Al_2O_3 28.87	per ct.	Al_2O_3	31.45	Al_2O_3 13.05
91.88			100.02	

This is a perfectly *neutral silicate*, and certainly this composition does not correspond to that of the English slag.

Neither magnesia, lime, alumina, or silica correspond, nor does the sum of the bases, 38.86, in one case, 49.28 in the other, offer any bases for a comparison. Still they are *both exactly neutral slags* and to all purposes, judging from the type, would have the same fusibility, and would accompany the same grade of iron. This is going to extremes, of course, in order to show how far the differences may be characteristic. *Hence, the apparent composition of a slag does not afford any means of comparison in certain cases and no sure one in any cases.*

It has occurred to the writer, and he has used this method extensively in practice, that, instead of calculating the formulæ, slags could be readily compared in the following manner. Admitting that slags are regular compounds, multiple silicates of the bases in RO and R_2O_3 of the same type, or even taking their empirical formula without any hypothesis or admission on this point, it is evident that, taking the saturation of the different bases for SiO_2, as given in the preceding table for the different types, if we calculate the proportional quantities of all the other earthy elements as *lime*, and then reduce the composition thus found to per. ct. we can show all slags to be composed simply of *silica and lime* in various proportions for each, as the case may be. If we compare the numbers thus obtained with the typical slags transformed in the same manner, we can ascertain at a glance not only to what type a given slag corresponds or between which types it falls, but also *how close* to a given type it comes; the percentage of *its "basicity,"* so to speak, and this, whatever may be the number or the nature of the bases entering into the composition of the silicate, since what has been said above regarding MgO and CaO will apply, with equal truth, to all the bases of the class RO, and, as regards Al_2O_3, to all bases of the class R_2O_3.

Referring to Table III. and transforming *all* of the bases into their equivalent in lime, and reducing to per. ct.; or, calculating directly from the formulæ RO, $2SiO_2$ . . . CaO, $2SiO_2$ (Table I.), we have:

TABLE V.

Composition.	Acid.	Sesquiacid.	Neutral.	Sesquibasic.	Bibasic.	Tribasic.	Quadribasic.
SiO_2%	68.19	61.65	51.72	41.66	34.88	26.30	21.13
CaO%	31.81	38.35	48.28	58.34	65.12	73.70	78.87
O of SiO_2 : O of bases.	4 : 1	3 : 1	2 : 1	4 : 3	1 : 1	2 : 3	1 : 2
1CaO saturates SiO_2*	2.143	1.6071	1.0714	0.714	0.538	0.357	0.268
1SiO_2 " CaO	0.466	0.622	0.932	1.400	1.858	2.829	3.732

Note A.—It must be noted here that if the corresponding formulæ, in which SiO_2 is taken as the symbol for silica instead of SiO_2, had been transforme l in the same way we should have

found exactly the same results as in Table V. or, at least, figures as near to the above as the differences in the numbers expressing the old and new equivalents of the same substance would have permitted; in fact, the hundredths only are affected, as previously remarked.

For instance, the formula 2RO, SiO_2 (Bibasic) corresponds to SiO_2 to 3RO, SiO_2; the equivalent of lime was formerly taken as = 28.25, that of silica at 45.25. We should have had then for the silicate 3CaO, SiO_2:

3CaO = 84.75 SiO_2 = 45.25	Reducing to per. ct.:	Lime, 65.19 Silica, 34.81
130.00		100.00

With the corrected equivalent, 28.00, and the new formula, 2RO, SiO_2, we have found:

Lime, 65.13 } the difference being only in hundredths.
Silica, 34.87 }
100.00

Having a table of the equivalence in lime of the different bases as far as saturation for silica is concerned (Table III. (a)) the calculations are very simple. Using this method, let us compare the typical neutral slag with the English slag of Percy mentioned above.

The neutral slag corresponds to SiO_2 51.72%, CaO 48.28 (Table V.) the English slag to and the composition of the slag is equivalent to

SiO_2 54.00 CaO 51.33	or	SiO_2 51.27 CaO 48.73		
105.33		100.00		
SiO_2 = 54		54.00		
Al_2O_3 = .13 × 1.631		21.25	CaO	}
MgO = 0.57 × 1.40		0.80	"	
FeO = 2.44 × 0.78		1.90	"	} 51.33 CaO.
MnO = 2.20 × 0.78		1.71	"	
CaO = 25.67		25.67	"	}

Compared with the type

SiO_2 51.71
CaO 48.28,

the differences are as close as we can come, using two places of decimals in analyses. Both slags are neutral; O of acid : O of bases :: 2 : 1. The English slag actually run from a charcoal furnace was exactly the chemical compound having the formula

$$RO, SiO_2 + R_2O_3, 3SiO_2 = (RO, R_2O_3, 4SiO_2),$$

the latter being the empirical formula. The first form supposes that the silicates in, RO and R_2O_3, are of the same type, and it is difficult to conceive how it can be otherwise in a slag. A slag is a

multiple silicate having a certain fusibility quite different from that of the simple silicates which enter into its composition; it must be then that silica is *so* combined with *all* the bases as to form a compound; having a definite constitution, which can be reproduced each time that the different bases may be taken in the same proportion to each other and to the silica, each base saturating silica, according to its possible saturation in *presence of the others*, in these conditions and this presence itself modifying the type. Any change in the quanitity of one of them—replacing a *given weight* of one by an *equal weight* of another—(not an equivalent weight as regards saturation for SiO_2)—must necessarily give rise to another saturation, since the ratio of the quantity of oxygen of the SiO_2, which has remained the same to the total amount of oxygen of the bases, which has been changed, is thereby modified.

There exists, indeed, in relation to these combinations of oxygen compounds a law by which one can readily reach the comparison of their analyses. The quantity of oxygen of one of the constituents, silica, is, in most minerals, a multiple or a sub-multiple of that of the others. The determination of these numbers furnishes ratios which can be reduced to their simplest expression. By so doing there is no hypothesis made as to the constitution of the substance, the results are furnished by the analysis itself, and if the quantity of oxgen of the acid element, silica, is divided proportionately to the quantity of oxygen found to exist in the bases in RO and to these in R_2O_3, and a rational formula deduced from the numbers thus calculated, it will be found invariably that the types of the silicates in RO and R_2O_3 are the same and the same as that of the compound itself, regarded as a multiple compound in RO and R_2O_3.

When in the analysis of a mineral the ratio of the quantities of oxygen can not be simplified, it is almost always to be attributed to the fact that these minerals have rarely crystalized alone, and that in these conditions one of them may have carried with it a certain quantity of other substances, as, when several salts are found together in the same solution; these foreign substances hide, so to speak, the real proportions, modifying to some extent the characteristic properties of the mineral. Nothing of the kind at any

rate can happen with a slag, considering that its type as silicate is determined beforehand in the charges of a blast furnace, by furnishing to the silica of ores, stone, and ash of coal, perfectly definite basic elements, in certain proportions primarily calculated, which necessarily determine a composition which the ultimate analysis of the slag, as run from the furnace, corroborates very closely in the great majority of cases. When it does not happen, it has also to be attributed to disturbing factors, and they can be found, for instance, in this fact that calcium, combined with sulphur, which the slags often contain in very serious quantities, has been calculated as oxide of calcium or *lime*. The same can be said of magnesium and manganese. 5% of sulphur in a slag is by no means an exceptional circumstance; 8% of manganese sulphide is frequently met with in Scotch slags. In other cases alumina, owing to certain condition of the furnace, or the proportions of fluxes, will play the part of an acid, and, in these conditions, ought not to figure in the determinations of the type as saturating silica.

(*To be continued.*)

DETERMINATION OF LITHIA IN MINERAL WATERS.

By E. Waller, Ph. D.

Practically, three methods are now available. 1. The phosphate method (Mayer's modification) (*Ann. Chem. u. Pharm.* **98,** 193). 2. The amylalcohol method (*Gooch, Am. Chem. Jour.*, **9,** 33). 3. The fluoride method (*Carnot, Bull. Soc. Chim.* [3] **1,** 280).

Rammelsberg's method (*Pogg. Ann.*, **66,** 79) somewhat similar in principle to that of Gooch, in that it depends upon the comparatively greater solubility of lithium chloride in an organic solvent, has been comparatively little used, on account of the difficulty and expense involved in obtaining the pure anhydrous alcohol and ether necessary for the process. Moreover the experiments of J. L. Smith (*Am. Jour. Sci.* [2] **16,** 56), rearranged in convenient form for reference by Gooch (*loc. cit.*) do not indicate that it is

very satisfactory in its application, even with the best of care. Some indirect processes, such as the weighing of mixed chlorides of sodium, potassium and lithium, and then determining the chlorine and potassium (Bunsen, *Ann. Chem. u. Pharm.*, **122**, 348), have been also proposed, but they are troublesome in execution, and likely to be unsatisfactory in result.

For all of these processes, it is necessary to obtain from some known quantity of the water, the alkalies as chlorides free from admixture with other bases, and in most cases, a considerable proportion of the sodium and potassium salts, which usually predominate largely over those of lithium, must be removed. To accomplish this the usual method may be followed, acidification with hydrochloric acid, evaporation, treatment with barium hydrate solution, removal of the excess of baryta by ammonium carbonate, driving off the ammonium salts, and extraction with alcohol or alcohol and ether, to take out the lithium chloride which is inevitably accompanied by some sodium and potassium chlorides. Throughout this treatment, the spectroscope must constantly be used to determine when the extraction or washing is complete and these preliminary operations often prove very tedious. Some suggestions in this connection may be of value. The small platinum wires used to test the precipitates, solutions, etc., need critical examination. A wire which has been once used with lithium salts may perhaps be held in the flame until it will give no trace of color to the flame, nor show the lithium line by the spectroscope, but on moistening with hydrochloric acid and inserting in the flame, the line will show almost as brightly and distinctly as if no lithium had been removed from it. Repeated scouring, immersion in acid and insertion in the flame, or long soaking in acid may be necessary to remove this trace of lithium from the wires. It has been found convenient to keep several wires dipping into a test tube partially filled with dilute hydrochloric acid, and to use them in succession, so that each wire shall have a tolerably long immersion in the acid, before being tested again, as a preliminary to using it for a test on a precipitate, etc.

Barium precipitates ($BaCO_3$ and $BaSO_4$) when formed in the presence of lithium compounds, carry down and retain perceptible

quantities of lithia (by spectroscope test) with great persistency. The well known tendency of the barium sulphate to drag other salts with it *seems* to be greater in the case of lithia than in that of other alkaline salts, although this may perhaps be due to the exceeding delicacy of the spectroscopic reaction. Precipitation in a rather dilute solution, and rather liberal washing is usually the most convenient course to pursue in the case of the precipitation of Ba SO_4 in presence of lithium salts. With Ba CO_3, re-solution in HCl, and re-precipitation with ammonia and ammonium carbonate is most effective. If the proportion of lithium is large, re-solution, and re-precipitation a third time may be advisable. The precipitate produced by barium hydrate, unless consisting largely of sulphate, does not give so much difficulty in the washing out of the lithia, except when it has been exposed for some time to the air of the laboratory containing CO_2.

A word further as to the decomposition of Li Cl by heat. Direct quantitative estimations upon the subject were not made in this investigation, but the phenomena noted tend to confirm Mayer's remark that under the influence of heat in presence of water, lithium chloride has a tendency to exchange chlorine for oxygen.

A solution containing lithium chloride is evaporated to dryness with difficulty when placed on the water bath, and if it finally is made to *appear* dry after prolonged treatment in this manner, more of the material is slow to re-dissolve in water (apparently because of the formation of lithium hydrate) than if the same solution is evaporated nearly to dryness and the moisture driven out by careful ignition over a naked flame.

Assuming in every case that one has obtained a concentrated aqueous solution from a known quantity of the water, containing all of the lithium and some of the potassium and sodium as chlorides, but no other bases, the phosphate method would be as follows :

Add an excess of hydro-disodium phosphate, and then a moderate excess of pure sodium hydrate, evaporate to dryness, re-dissolve in water by the aid of a gentle heat, add an equal volume of strong ammonia, digest warm for some time, allow to stand for twelve hours, filter and wash with a mixture of equal volumes of ammonia

and water, and finally ignite and weigh as $Li_3 PO_4$. A second or third portion of precipitate may be recovered, by evaporating the filtrate and washings, adding ammonia and allowing to stand as before, filtering, etc. The chief difficulty with the accuracy of the process, consists in the practical impossibility of obtaining all the lithium as phosphate, free from any other alkaline salts. Too much washing will cause appreciable amounts of lithium phosphate to go into solution. Indeed, in my experience the filtrate and washings have always showed a decided lithia line in the spectroscope, from the start. On the other hand, too little washing leaves some alkaline salt along with the lithium phosphate—shown by its tendency to cake on ignition—but whether it cakes or not, lithium phosphate separated by this method when tested by the flame, almost invariably gives so strong a sodium flame, as practically to obscure the red of the lithium to the naked eye. Consequently it becomes to a considerable extent a matter of judgment, to decide when the washing is completed, and *then* the amount of lithium phosphate obtained is a compromise between the precipitate dissolved off by washing, and alkaline salts left with it. However, by the aid of a little experience, the error can be usually brought within moderate limits, if the proportion of water which the chlorides represent is sufficiently large (ordinarily 10 to 20 litres). The use of such large quantities of water is naturally attended with more or less labor, in evaporation, removal of bases, etc., and is in itself objectionable aside from the sources of error inherent in the method of determination. This method has, however, until recently been practically the only one in general use.

The method of Gooch (*loc. cit.*) used by him in the examination of the waters of the Yellowstone Park (*Bull. U. S. Geol. Survey*, No. 47, also *Chem. News*, **59**, *113, et seq.*), may be described as follows: The concentrated solution of the alkaline chlorides should contain only about 0.2 grm. of salts in all. To this solution, in a casserole or dish, is added 30 to 50 c. c. of pure *anhydrous* amyl alcohol. The vessel is then heated on a sand bath over a low flame, so as to boil off the water through the amyl alcohol, leaving the undissolved salts adhering to the sides of the dish. The heat is kept up until the volume of amyl alcohol has

been reduced to about 15 or 18 c. c. after cooling. A few drops of hydrochloric acid are added to restore to the form of chloride any lithium oxide or hydrate which may have been formed, and the heating is repeated for a short time. The amyl alcohol is then filtered through paper, or through a Gooch crucible, into a measuring cylinder, and its volume noted (usually 10 to 15 c. c.). In case the proportion of lithium is large the undissolved salts should be taken up with a little water, and the treatment repeated in the same way as just described, the amount of amyl alcohol which has been heated with the chlorides being measured as before. The salts are then washed with cold amyl alcohol until no trace of lithium is perceptible in them by the spectroscope; the filtrate and washings are evaporated in a weighed platinum dish, and the chlorides converted into sulphates, ignited and weighed. From this weight, for every 10 c. c. of amyl alcohol which remained in contact with the chlorides after heating, the following deduction is made:

When only sodium and lithium chlorides were present,	0.00050 grm.
" " potassium " " " "	0.00059 "
When both sodium and potassium, as well as lithium chlorides were present, - - -	0.00109 "

The cold amyl alcohol used for washing dissolves so little that it is needless to take it into account.

The relative solubilities of Na Cl, KCl and Li Cl in amyl alcohol, as determined by Gooch, are essentially:

Na Cl	1 in 30,000, or	0.0041 grm. in	100 c. c.
K Cl	1 " 24,000, or	0.0051 "	100 "
Li Cl	1 " 15, or	6.60 "	100 "

Temperature seems to have but little influence upon the solubility of Na Cl and KCl.

Pure amyl alcohol freed from water by boiling, if necessary, is indispensable.

Gooch's test experiments with mixtures of pure salts may be here quoted, arranged in a form slightly different from that given in his paper. The Li_2SO_4 obtained was calculated back to Li Cl in every case. The error is noticeably greater in the presence of potassium chloride.

Ex. pt. No.	Conditions.		Li Cl taken.	Errors in corrected weight of Li Cl found.
(23)	Na Cl only	Single	0.1298 grm.	0.0002— grm.
(24)	" "	Extr'n	0.1227 "	0.0002— "
(32)	" "	Double	0.1287 "	0.0007— "
(33)	" "	Extr'n	0.1347 "	0.0006+ "
(26)	KCl only	Single	0.1256 "	0.0008— "
(27)	" "	Extr'n	0.1287 "	0.0010— "
(34)	" "	Double	0.1125 "	0.0003+ "
(35)	" "	Extr'n	0.1251 "	0.00011+ "

The average of these errors is 0.0001— with a range from 0.0013— to 0.0011+ or if we calculate to the equivalent in Li H CO_3 from 0.0016— to 0.00176+, a difference of 0.00376 grm.

The process has the advantage that the sodium and potassium chlorides are left in a condition for the determination of those bases, in which case, however, an allowance must be made for the small amounts dissolved by the amyl alcohol which was heated with the chlorides. One disadvantage of the process is to be found in the fumes of the amyl alcohol which, even in a well ventilated laboratory is a source of great discomfort to most analysts.

The small amount of water, 100 to 200 c. c. that can be used for this process is advantageous, though for those accustomed to the use of the phosphate process, the amount seems hardly large enough to give a fair average, and to average on a larger amount requires the concentration of the Li Cl by extraction with alcohol or alcohol and ether. In some of the first trials made with the process, the amount of mixed chlorides experimented upon considerably exceeded 0.2 grm., probably nearly 1. grm. and in some cases more. This was because Prof. Gooch's paper seemed to imply that the operation might be reasonably expected to be successful, when applied to quantities ordinarily handled in analytical work. In the case of one water it did prove so, but with another water, containing more lithia as well as alkaline salts it was not. The removal of all the water in the manner described, was a matter of extreme difficulty, and curiously enough, a limit seemed to be reached, beyond which the Li Cl was extracted, but slowly and with great difficulty. The results may prove interesting.

The alkaline salts from two equal quantities of a water, each lot amounting to between one and two grammes, were treated as described :

Obtained from A	0.2400	grm. $Li_2 SO_4$	from B	0.2354	$Li_2 SO_4$
Found in insoluble part. f. A	0.0974	"	" B	0.0943	"
Total	0.3374	"		0.3297	"

The control process used in this case was Carnot's fluoride method, which cannot however be regarded as absolutely free from imperfections. It is as follows : the mixed alkaline chlorides after evaporation nearly to dryness, are extracted with a mixture of about equal volumes of alcohol (of 90% or over) and ether, so as to obtain the Li Cl comparatively free from the others. It was found most convenient to add the alcohol ether mixture, and allow to stand for some time with frequent stirring, and then after standing over night to filter through a small filter, and wash with alcohol, one extraction will often suffice. A second extraction may however be necessary, the work being of course controlled by the indications of the spectroscope. After evaporating off the alcohol and ether, the salts are dissolved in the least possible quantity of water, and filtered into a weighed platinum dish. The filtrate and washings should then be concentrated to small bulk (5 or 10 c.c.) and pure ammonium fluoride and ammonia added; after thorough mixing the dish is set aside over night for the Li F to precipitate. The solution is then decanted through a small filter, and the precipitate is washed by decantation three or four times (5 to 7 c.c. at a time), with a solution consisting of the reagent mixed with 5 to 10 times its bulk of ammonia ; between decantations the solution must be allowed to stand some little time with stirring. The bulk of filtrate and washing (30 to 50 c.c.) is noted, the filter paper and contents placed in the dish, sulphuric acid added, and heat applied until the paper has been incinerated, and the lithium converted to sulphate, in which form it is weighed. To this weight is added 0.0040 grm. for every 7 c.c. of filtrate and washings, and the result estimated as $Li_2 SO_4$ is calculated to Li, Li HCO_3, etc., according to the requirements of the case.

Care is necessary in preparing the reagent, and wash liquor.

Carnot seems to have found that the ammonium fluoride ordinarily supplied for laboratory use, is the only member of the combination liable to contain impurities which would interfere (chiefly fluosilicic acid, which might precipitate alkaline fluosilicates), but

experiments have shown that ammonia, which has been standing for some time in contact with glass, will give a cloud (presumably ammonium fluosilicate) with a mixture of solutions of ammonium fluoride and ammonia after boiling and filtering clear. This solution, so long as it contains a fair amount of free ammonia, appears to be without action upon glass. It has been found advisable therefore to make up (and cork up) the reagent and washing solution some time beforehand, and to filter off such portions as may be required at the time of using. Naturally, it is necessary to use for the final filtration, a filter paper which has been extracted with hydrofluoric acid. Schleicher & Schull's papers were found satisfactory in this connection. Carnot also recommends that the resulting Li_2SO_4 should be dissolved in 40 to 50 c.c. of water, and a test made for the presence of magnesium, which may have remained with the alkaline chlorides. If any is found to be present, it must be determined as phosphate and a correction made accordingly.

In connection with this process it was observed that lithium sulphate ignited in contact with the carbon of the filter paper, is especially prone to reduce to sulphide and especial caution is necessary at this stage of the operation. The sulphide, when heated in contact with the platinum, attacks it in a very marked manner.

The process seems to be very good, although not rapid.

Its tendency is to yield results a little high, apparently because the allowance for solubility is usually larger than the actual amounts of precipitate dissolved. Test analysis tended to show also that unless the amounts of potassium and sodium chlorides present with the lithia are kept within narrow limits, the results will be high.

Unfortunately a number of the tests and comparison experiments with these methods have not yet been completed, and will have to be deferred to a second communication.

I order to test these methods upon water containing lithia, samples of several of the best known and widely advertised waters were purchased and submitted to examination.

The results were somewhat surprising, and showed unquestionably that either the original analyses, on the strength of which those waters are now sold, were erroneous, on account of imper-

fection in the methods used, or, what is more probable, that the proportions of lithium in those waters are liable to great fluctuations.

The results given were chiefly obtained by Carnot's fluoride method, but were in several cases confirmed by the use of other methods. The most scrupulous care was exercised to be sure of obtaining *all* of the lithium in the waters under examination, the spectroscopic indications having been used at every stage of the process.

In the Farmville Lithia Water, purchased at the office of the company, no lithium could be detected by the spectroscope on moderate amounts of the water. On evaporating eight litres of the water, and treating in the manner described for the concentration of the lithia into a solution of small bulk, a lithia line was obtained in the spectroscope, but the amount was found to be too small to permit of a quantitative estimation. The experiment was repeated with ten litres of the water, with essentially the same result.

With the Buffalo Lithia Water the reaction for lithium was more distinct, when considerable quantities of the water were concentrated. From 20 litres of the water was obtained lithium sulphate corresponding to 0.0185 part Li HCO_3 per 100,000.

In the Londonderry water, the lithia reaction could be obtained without great difficulty. Analysis of the water purchased by myself showed a little over 4 parts per 100,000. The company puts up some of the water in half-gallon bottles not charged with CO_2, and also some in pint bottles (called in their circulars "sulphocarbonated"), which is charged with CO_2, and has also received the addition of some salts. The amounts of salts added appears to be somewhat irregular. For instance, the following results were obtained (results given in parts per 100,000):

	Total solids.	Loss on ign.
Londonderry, half-gallon bottles (aver.)	37.35	2.25
" pint bottle, A	149.4	4.9
" " B	104.2	4.5
Average of eleven others	224.7	6.4

The variations in the eleven bottles were 221.3 to 231.4, for total solids. The proportion of lithium was essentially the same as for the still water.

I was told that several lots of water, purporting to come from these springs, had at times appeared on the market in which no lithia could be detected. As I learned that Dr. Endemann had obtained some water of that kind, I requested him to send me a bottle. He complied, and although the bottle bore all the labels and marks similar to those purchased by myself, no lithia could be detected in it. The water contained 5.2 parts total solids per 100,000. I have heard of others who had similar experiences.

I naturally desired to obtain samples of these waters direct from the springs, taken by some one whom I knew to be disinterested. Attempts thus far have been unsuccessful. In the case of the Londonderry springs, all access is denied to visitors, and applications for water are referred to the bottling establishment in Nashua.

Of all the waters examined, purporting to be natural, the Saratoga Hathorn proved to be the strongest in lithia. The result of tests on this water are not at present in such form that they can be here recorded, but it suffices to say that the water contains fully as much as the analyses call for (12 to 14 parts Li HCO_3 per 100,000, corresponding to 7 or 8 grains per U. S. gallon).

Tests were also made on the waters manufactured and sold by Carl H. Schultz as containing lithia. They were found to contain a little more lithia than claimed. E. g., the formula on his "Vichy with Lithia," calls for an amount corresponding to about 57 parts Li HCO_3 per 100,000. The analyses showed 60 to 62 parts.

The results enumerated may be thus tabulated:

Designation of Water, etc.	Total Sds. Per 100,000.	Loss on Ign.	Non-Volatile.	Used for Determination.	Li HCO_3 Per 100,000	Li HCO_3 Grs. U. S. Gal.	Li HCO_3 Grs. Imp. Gal.
Farmville Lithia, half gal. bottles	16.4	1.1	15.3	8.L	traces.		
" "	....	....	....	10.L	traces.		
Buffalo Lithia, half gal. bottles...	93.2	6.5	88.7	20.L	0.0185	0.011	0.013
" "	....	....	....	20.L	0.0135	0.008	0.009
Londonderry Lithia hf. gal. bot's.	37.35	2.25	35.1	10.L	4.171	2.432	2.920
" "	....	....	....	10.L	4.075	2.376	2.852
" "	....	....	....	2.L	4.130	2.408	2.891
" " pts (c'h'g'd CO_2)	....	....	....	2.L	4.129	2.407	2.890
" " "	....	....	....	4.L	4.074	2.376	2.851
" " (hf. gal. Dr. E.)	5.1	1.	4.1	1.L		none	

ABSTRACTS.

GENERAL AND INORGANIC CHEMISTRY.

Eukairite from Argentinia. Robert Otto.

Berzelius and later A. E. Nordenskjöld analyzed a rare mineral, consisting of an equal number of atoms of silver, copper and selenium. This mineral was found in minute quantities in the copper mine Skrikerum in Smöland, Sweden. Emil Hünicken has found in Villa Argentinia, Prov. Rioja, Argentine Republic, in Arnango in the Andes of Famatina and in other places, a peculiar mineral, which was sent for exact analysis to the author. The mineral occurs in veins, some of which have a width of 1 c.m. but at a depth of 14 m. are 35 c.m. broad. The mineral, according to analysis, is the same as Berzelius' Eukairite, and consists of:

Ag = 42, 7 per cent.
Cu = 25, 5 "
Se = 31, 5 "

(*Ber. d. Chem. Ges.*, **23**, *1039.*) L. H. F.

On Spontaneously Inflammable Hydrogen phosphide. L. Gattermann and W. Hausknecht.

For the extensive and interesting details of this remarkable research we refer to the original paper. This liquid phosphine was obtained pure from calcium phosphide prepared in an original manner. An analytical determination of phosphorus was not feasible. But the hydrogen was determined by means of combustion with lead chromate. Figures were found agreeing with the formula PH_2. Also the decomposition by sunlight furnishes figures corresponding to that formula. The attempt to determine the vapor density in V. Meyer's apparatus, below the boiling point of the substance, using methyliodide as a mantle, was not successful. Quite a number of determinations pointed towards the formula P_2H_4 (66) since values such as: 74, 73 and 77 were obtained.

The boiling point was determined successfully. It does *not* lie at temperatures between 30° and 40° C., as the handbooks state,

but was found to be 57° to 58° C., at 735 m. m. The following figures were found in determining the specific gravity:

(I.) Spec. Grav., 1.016.

(II.) Spec. Grav., 1.007.

It follows that this hydrogen phosphide is slightly heavier than water, and this fact was confirmed by direct experiment which showed a large drop of the liquid to sink in water. (*Ber. d. Chem. Ges.*, **23**, *1174, 1890.*) L. H. F.

Vapor Density and Melting Point of Cyanogen Iodide. KARL SEUBERT and WILLIAM POLLARD.

The two above named determinations have heretofore not been performed. The substance is very volatile and strongly poisonous. The cyanogen iodide was prepared in the manner used by Davy and described by Serullas; action of iodine upon mercuric cyanide. The equation:

$$\underset{251.76}{Hg(CN)_2} + 2\,\underset{506.16}{I_2} = Hg\,I_2 + 2\,CNI$$

calls for one part of mercuric cyanide and two parts of iodine, while Serullas recommends exactly the reverse, *i. e.*, 2 pts. Hg $(CN)_2$ to 1 pt. of iodine. The great excess of the former should prevent volatization of free iodine. The authors used mixtures according to the above equation or in the proportion of equal parts of the two substances. But they were careful to allow the reaction to take place very slowly and spontaneously, in direct sunlight, during 2 to 3 days, using peculiar apparatus. The product obtained, which cannot easily be analyzed gravimetrically, allowed titration in the simple manner, given by E. v. Meyer. According to the latter, cyanogen iodide and hydriodic acid, *in excess*, decompose as follows:

$$ICN + HI = I_2 + HCN.$$

The liberated iodine is titrated in the ordinary manner. Instead of using a solution of HI, E. v. Meyer proposes to apply a solution of KI acidulated with H_2SO_4. The vapor density obtained by Victor Meyer's method led to the formula CNI, analogous to CNCl and CNBr. The melting point was determined in the ordinary way, in a capillary tube, but this latter had to be sealed

at both ends, the substance volatilizing below its melting point. The bath used was H_2SO_4. The results obtained were:

	Melting Point.	Congealing Point.
a	146,5°	143°
b	146,5°	142,5°
c	146,5°	142,5°

(*Ber. d. Chem. Ges.*, **23**, *1062.*) L. H. F.

A New Apparatus for Determination of Melting Point. A. C. CHRISTOMANOS.

This interesting apparatus allows the substance, the melting point of which is to be determined, to float on mercury, which can be heated, while a little mercury rests on top of the substance. An electric bell is connected with the two quantities of mercury, separated from one another by the substance to be tested. When the latter melts, the mercury flows together, the bell rings and the thermometer is read. (*Ber. d. Chem. Ges.*, **23**, *1093.*) L. H. F.

ORGANIC CHEMISTRY.

Determination of Different Sugars by Cupro-potassium Carbonate Solution. H. OST.

This research is based upon the proposition which was made in 1876 by A. Soldaini, to use a solution of copper carbonate in potassium bicarbonate instead of Fehling's solution. This solution has, so far, not been adopted because it is difficult to obtain of constant composition and because its action upon invert sugar is too slow. The author proposes two solutions, which have been useful to him. One consists of:

23, 5 grms. cryst. copper sulphate,
250 " potassium carbonate,
100 " potassium bicarbonate,

per litre. First the potassium salts are dissolved, then the copper solution is gradually added. The action of this solution depends not only upon the presence of copper, but also upon that of potassium carbonates and upon the strength of the sugar solution. It

is available for volumetric as well as gravimetric analysis, and is applicable for titrations of mixtures of sucrose with but little glucose. Fehling's reagent gives very unreliable results for such mixtures. Besides this, the end of the reaction, which is manifested by a yellow coloration when using Fehling's solution, is indicated for the above liquid by a colorless, transparent appearance of the mixture. For sucrose very poor in glucose, as for instance in beet sugar, the above solution is too concentrated, and a solution of the following strength is used :

3, 6 grm. $SO_4Cu + 5\ H_2O$,
250 " CO_3K_2,
100 " CO_3KH,

per litre. This solution should only be used gravimetrically. (*Ber. d. Chem. Ges.*, **23**, *1035.*) L. H. F.

Ethoxyacrylic Acid from α-Dichlorpropionic Acid. ROBERT OTTO.

According to W. Merz alcoholic potassium, when acting upon α-dibrompropionic acid forms ethoxyacrylic acid. The reaction performs in two phases :

(I.) $CH_3 . CBr_2 . COOK + KOH = CH_2 : CBr . COOK + KBr + H_2O$.

(II.) $CH_2 : CBr . COOK + C_2H_5OK = CH_2 : COC_2H_5 . COOK + KBr$.

The author, together with G. Holst has now prepared this same acid from α-dichlorpropionic acid. It forms white crystals, melting at 110° C. (*Ber. d. Chem. Ges.*, **23**, *1108, 1890.*) L. H. F.

Friedel-Craft's Synthesis of Ketones from Phenolethers. L. GATTERMANN, R. EHRHARDT and H. MAISCH.

The results obtained are summed up by the authors as follows :

Phenolethers react very smoothly with acid chlorides, forming ketones of extraordinary capacity of crystallization. Almost all of them may be obtained in measurable crystals. Mineralogists are thus offered splendid material to study the relations between form of crystals and constitution. The law which Leuckart noticed for phenyl cyanate and which Gattermann observed for urea chloride

with hydrocarbons and phenolethers, is illustrated, namely, that, in the case of an unoccupied para position, this is filled out by the acid residue entering. Sometimes, besides the normal ketone, an unsaturated alkylene compound is formed. This latter is generated from one molecule of a normal ketone and one molecule of unattacked phenolether by the joint loss of water. (*Ber. d. Chem. Ges.*, **23**, *1199*, *1890*). L. H. F.

Action of Ammonia on Di- and Tri- Halogenated Substitution Products of Hydrocarbons. P. GALEWSKY.

It has been shown of late by Udransky and Baumann that diamines may be precipitated almost quantitatively from very dilute, aqueous solutions by treating these with benzoyl chloride and dilute NaOH. The precipitates represent the corresponding benzoyl compounds. The present research was commenced with the intention to learn by means of this benzoylchloride reaction, whether alkylene bromides, treated with alcoholic ammonia in the cold, would yield diamines even in small quantity. Ethylene bromide allowed the formation of the diamine at ordinary temperature, propylene bromide required higher temperature. Tribromallyl yielded neither a di- nor a tri- amine, but as a result of this reaction a brominated monamine was formed :

$$C_3H_4\ Br.\ NH.\ CO.\ C_6H_5.$$

The amine was proved to be identical with the bromallylamine recently prepared by Paal and Hermann ; it may have either of the following constitutional formulæ :

(a) $CH_2.\ NH_2.\ CH:CHBr$

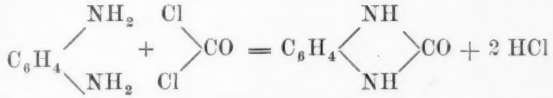
(b) $CH_2.\ NH_2.\ C\ Br:CH_2$

It should be remarked, that the bromine atom is very closely linked in this compound and does not admit of the formation of a diamine when heated with alcoholic ammonia to 200° C. The yield of bromallylamine according to the above method is not at all a quantitative one. (*Ber. d. Chem. Ges.*, **23**, *1066*.) L. H. F.

Action of Phosgen upon o-Diamines. A. HARTMANN.

Heretofore this action has only been mentioned by Michler and Zimmermann in regard to m-phenylendiamine. It has now been

studied further and it is found that a ring-formed, closed chain of ureas is obtained under the influence of phosgen, which occurs in general according to the following equation for phenylendiamine :



(*Ber. d. Chem. Ges.*, **23**, *1046.*) L. H. F.

Behavior of Sodiumphenyl mercaptide with Isobutylenbromide. ROBERT OTTO.

This reaction did not take place in a normal manner, according to the equation :

$$(CH_3)_2\,C.\,Br.\,CH_2\,Br. + 2\,C_6H_5\,SNa = 2\,Na\,Br. + (CH_3)_2\,CS.\,C_6H_5.\,CH_2SC_6H_5$$

but, apparently quantitatively, in the following manner :

$$(CH_3)_2\,C.\,Br.\,CH_2\,Br. + 2\,C_6H_5SNa = 2\,Na\,Br. + (C_6H_5)_2\,S_2 + (CH_3)_2.\,C : CH_2$$

yielding sodium bromide, phenylene disulphide and *isobutylene.* This latter, under the influence of hydriodic acid, was easily transformed into the iodide of tertiary butylic alcohol :

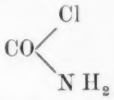
$$(CH_3)_2\,CI.\,CH_3$$

boiling at 98° to 99° C.

(*Ber. d. Chem. Ges.*, **23**, *1051.*) L. H. F.

A Modification of the Urea chloride Synthesis. L. GATTERMANN and A. ROSSOLYMO.

About two years ago a method was described by Gattermann, Schmidt, Hess and Harris, according to which



reacting with aromatic hydrocarbons and phenolethers in the presence of aluminium chloride effects a synthesis of carbo acids. Urea chloride is formed from phosgene and ammonium chloride.

Large quantities of liquefied phosgene gas are necessary for this reaction. In order to simplify the method, it was attempted to avoid the use of phosgene. Since urea chloride at the higher temperatures at which these syntheses were performed dissociates into cyanic acid and hydrochloric acid, the use of a mixture of these two was indicated. Cyanic acid may be prepared from cyanuric acid, which furnishes three molecules of the former, when heated carefully. It should be remarked, that although it was found that the mixture of cyanic acid and hydrochloric acid allowed a synthesis in the above mentioned sense for *small* quantities of carboacids, the old method, using urea chloride has to be resorted to when larger quantities are desired. Cyanuric acid was prepared by the action of bromine upon potassium ferricyanide. It has to be applied in a perfectly anhydrous state, because *cyanic* acid, when brought in contact with water decomposes, according to the equation.

$$CONH + H_2O = CO_2 + NH_3$$

The following table shows the hydrocarbons or phenolethers used in this manner and the melting points of the acid amides obtained:

Hydrocarbons or Phenolethers.	Melting Point of the Acid Amide.
Benzol	127° C
Toluol	156 "
o-Xylol	165 "
m-Xylol	180 "
p-Xylol	186 "
Pseudocumol	200 "
Durol	173 "
Naphthalene	202 "
Acenaphthene	198 "
Anisol	163 "
Phenetol	202 "
α-Naphthylmethylether	234 "
α-Naphthylethylether	244 "
β-Naphthylmethylether	186 "
β-Naphthylethylether	161 "

(*Ber. d. Chem. Ges.*, **23**, *1190, 1890.*) L. H. F.

Aldehydes of the Hydrocynnamic Acid Series. W. VON MILLER and G. ROHDE.

According to the preceding communication, the data found in the literature of hydrocynnamic aldehydes are to be stricken out. The authors have now prepared some genuine representatives of this series, which offer, besides the other well known characteristics of *aldehydes*, the following special ones :

1. They possess a very characteristic and agreeable odor, suggestive of lilac or jessamine ;

2. With concentrated or slightly diluted sulphuric acid they furnish liquids which, in transmitted light, are more or less intensely rose or carmine colored.

These aldehydes were prepared by means of destructive distillation of the calcium salts of the corresponding acids with calcium formate. (*Ber. d. Chem. Ges.*, **23**, *1079.*) L. H. F.

On Sulphocyanogen and Selenocyanogen Compounds. L. HAGELBERG.

Buff and Sonnenschein discovered ethylene rhodanide almost simultaneously in the year 1855. In 1874, Lermontoff prepared the methylene rhodanide. No other dirhodanides of the formula $Cn\ H_{2n}\ (SCN)_2$ are known in the fatty series. The author has now prepared :

Trimethylene rhodanide=NCS. CH_2. CH_2. CH_2. SCN

Propylene rhodanide=CH_3. CH. SCN. CH_2. SCN

Propylene selenocyanide=CH_3. CH. Se. CN. CH_2 Se CN

and derivatives of these compounds. (*Ber. d. Chem. Ges.*, **23**, *1083.*) L. H. F.

Contributions to a Knowledge of Etard's Reaction. W. VON MILLER and G. ROHDE.

The authors intended to perform the synthesis of indene derivatives starting from cynnamic aldehydes. This synthesis would have implied the assumption of a formation of hydrocinnamic aldehydes. According to Etard, hydrocynnamic aldehyde can be prepared from propylbenzol by the action of chromyl chloride. He maintained that, as with the other homologues of benzol, the re-

action was accomplished according to the following two equations:

(a) $R.CH_3 + 2\,CrO_2Cl_2 = R.CH:[O_2Cr_2(OH)_2Cl_4]$

(b) $3\,R.CH:[O_2Cr_2(OH)_2Cl_4] + 3\,H_2O = 3\,R.COH + 12\,HCl + 2\,Cr_2O_3 + 2\,CrO_3$.

The authors, in treating propylbenzol in this way did *not* obtain hydrocinnamic aldehyde but its isomere, benzylmethylketone together with benzaldehyde. When the mixture of these two latter was treated with oxidizing reagents, stilbene resulted. Hydrocinnamic aldehyde alone, or mixed with benzaldehyde, when subjected to a condensation experiment does *not* furnish stilbene.

Thus Etard's reaction, which formerly was considered as one leading to aldehydes, had in this case generated a ketone. A series of critical experiments, performed with cymol and ethylbenzol in the same manner, showed that also in these cases ketones are formed, contrary to Etard's data; phenylethylaldehyde is formed only in case of ethylbenzol. (*Ber. d. Chem. Ges.*, **22**, *1070.*)

L. H. F.

Researches on Diazo Compounds. LUDWIG GATTERMANN.

Experiments which were performed with the intention of forming diphenyl from diazobenzol chloride by the action of metals, such as zinc dust, iron or copper powder, showed that copper at 0° C. reacts very strongly, but that no diphenyl but only chlorbenzol was formed. Following up this observation it may be stated, that in this manner also the amido group of aniline and of its homologues was replaced by bromine, cyanogen, the nitro and the sulphocyanogen groups. A fortunate accident finally showed that when diazobenzol sulphate was acted upon by powdered copper in the presence of alcohol, diphenyl was formed and *not* phenolether as anticipated. The cheaper zinc and iron *in the presence of alcohol*, react in the same manner to form diphenyl. (*Ber. d. Chem. Ges.*, **23**, *1218, 1890.*)

L. H. F.

On Ethanedichinolyline. A. M. COMEY.

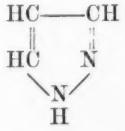
In order to give a wider application to Skraup's reaction, the author made paradiamidodibenzyl, nitrophenol, sulphuric acid

and glycerol react together. The base obtained crystallizes in colorless, hexagonal plates of melting point 124° C. The analysis led to the formula $C_{20}H_{16}N_2$. Since the two amido groups of diamidodibenzyl are in para position, the new base must be para-ethanedichinolyline, isomeric with Bulach's ethanedichinoline, melting at 106.5°. (*Ber. d. Chem. Ges.*, **23**, *1115, 1890.*)

L. H. F.

Synthesis of Pyrazol. L. BALBIANO.

This body resulted from the reaction between hydrazinhydrate and epicholorhydrine. The analysis confirmed the formula C_3H_4N. Pyrazol crystallizes in hard, colorless needles. It dissolves in water to form a neutral solution. The odor is faintly suggestive of pyridine. Melting point: 69. 5–70 C. Boiling point: 186–188° C., at 757.9 m. m. The properties of pyrazol correspond with those of a body prepared by Buchner from acetylenedicarbodiazoacetic acid. This latter substance when heated to 230–240° C. decomposes into CO_2 and $C_3H_4N_2$, the latter probably having the constitution :



(*Ber. d. Chem. Ges.*, **23**, *1103, 1890.*) L. H. F.

A New Lutidine. E. DÜRKOPF and H. GÖTTSCH.

This base was obtained from dimethylpyridine carbo acid by splitting off CO_2. It is dried over KOH and boils then at 169–170° C. The analyses corresponded to a lutidine C_7H_9N. It is a clear, strongly refractive liquid of a mild, pleasant odor, characteristic of the β-compounds. It is more easily soluble in cold than in warm water. Spec. Grav. referred to water of + 4° C, is 0.9614, at 0° C. A two per cent. solution, oxidized in the cold furnished dinicotinic acid. This lutidine is therefore $\beta\beta'$-dimethylpyridine. (*Ber. d. Chem. Ges.*, **23**, *1113, 1890.*) L. H. F.

On the Formation of the Quinolin Ring; a Contribution to the Benzol Theory. W. MARCKWALD.

v. Baeyer's researches (*Ann. Chem., Liebig*, **245**, *103*; **251**, *257*) show that the only three formulæ to be considered in regard to the constitution of benzol are, his own centric formula, Kekulé's and Dewar's.* It was to be expected that the study of quinoline derivatives formed from aromatic diamines by one of the known synthetical methods, would lead to a decision in favor of one of these formulæ. All of the syntheses which the author has performed lead to phenanthrene ring formations, which speaks in favor of Kekulé's formula. (*Ber. d. Chem. Ges.*, **23**, *1015.*)

L. H. F.

On Indian Geranium Oil. F. W. SEMMLER.

Fractional distillation at 17 m. m. pressure furnished 92 p. ct. of an oil boiling at 120.5 to 122.5 C. The analysis gave correct figures for a compound $C_{10}C_{18}O$, which proved to be geraniol. It does not congeal at–20° C. The odor, which is still more agreeable in the refined than in crude oil, suggests the perfume of the pear or the rose. It is colorless and of Spec. Gr. 0.8900 as 15° C. The alcoholic nature of geraniol has been shown by Jacobsen. The optical methods, as well as the behavior toward iodine and bromine, indicate two ethylene linkings, and consequently this compound $C_{10}H_{18}O$ cannot have a ring-formed constitution. It belongs to the fatty series, $C_nH_{2n-2}O$. Potassium permanganate oxidizes it to isovaleric acid. Under the influence of P_2O_5 terpenes and polyterpenes are formed. (*Ber. d. Chem. Ges.*, **23**, *1098, 1890.*)

L. H. F.

The Curves of Boiling Temperatures a Function of the Chemical Nature of Compounds. M. WILDERMAN.

A simple rule for the determination of the boiling points of organic compounds at reduced pressure. Considering the great number of boiling point determinations at different pressures,

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*In regard to this assertion see *Ber. d. Chem. Ges.*, **23**, 1276. It is expressly mentioned there, that Dewar's formula need *not* be considered.

L. H. F.

recorded by Regnault, Schumann, Anschütz and others, the author endeavored to find out whether the relation between pressure and boiling point of a substance has any connection with its chemical nature. About twenty homologous series were arranged and the following result was shown: Within tolerably wide limits of pressure, as between 1500 m. m. and 50 m. m., or, 760 m. m. and 12 m. m. the proportion of the absolute boiling point at M m. m. pressure to that of N m. m. is very nearly constant for all members of the homologous series. The tables given show that the *calculated* boiling points of a compound for an arbitrary pressure of N m. m. differ from the observed boiling point merely by a fraction of *one* degree. This is a difference which lies within the limits of error with which a boiling point can really be determined.

For members of the homologous series the following formula is an approximate expression:

$$\frac{T\,a\,p}{T\,a\,P} = \frac{T\,b\,p}{T\,b\,P} = \frac{T\,c\,p}{T\,c\,P} = D_1 \quad (I)$$

in which a, b, c signify different members of the homologous series, p and P lower and higher pressures.

From this main formula five others of importance are derived. It follows from all of them, that the change of boiling point of a compound at a different pressure is really a function of its chemical nature. Bodies containing atoms of the same kind, and having the same constitution, which, consequently, are chemically equal, give the same numerical value. Different homologous series show considerable deviation. This is of great practical importance, particularly for compounds which decompose at ordinary pressure when the attempt to boil them is made. The formula given require merely the knowledge of *one* boiling point. (*Ber. d. Chem. Ges.*, **23**, *1254, 1890.*) L. H. F.

Abstracts of American Patents Relating to Chemistry.

(*From the U. S. Patent Office Gazette.*)

Issued May 27, 1890.

428,587.—Hydrocarbon burner. R. B. Avery and R. F. Smith.

428,589.—Diffusion apparatus. L. Boyer.

428,610.—Lubricant. S. Hopkins, Jr.

Consists of rod wax, lard and castor oil.

428,614.—Dyeing apparatus. C. L. Klauder.

428,629.—Substantive yellow dye. W. Pfitzinger.

Prepared by combining the diazo conpounds of the thio derivatives of paratoluidine, metaxylidine, and pseudo cumidine or those of their sulpho-acids with the sulpho-acids of the thio derivatives of paratoluidine, metaxylidine and pseudo cumidine.

428,638.—Air pump. H. Schulze-Berge.

428,654.—Process of manufacturing thin sheets of nitrocellulose. E. N. Todd.

428,659.—Process of melting the ores of copper or other metals. C. Wessell.

The broken ore is mixed with potassium carbonate, sodium chloride, sodium nitrate and boric acid, and heated to the melting point.

428,687.—Composition for converting malleable cast iron into steel. W. J. Miles, Jr.

Consists of potassium ferrocyanide, potassium cyanide and potassium carbonate.

428,747.—Bottom for reducing furnaces. C. J. Eames.

Consists of dolomite, carbon, fluorspar, fire clay, fire sand and sufficient of a weak solution of sodium silicate to form a plastic mass.

428,830.—Apparatus for oxidizing or desulphurizing ores. E. M. Clark.

428,834.—Method of welding aluminium. M. Emme.

428,955.—Apparatus for the manufacture of gas. J. M. Rose.

428,956.—Apparatus for the manufacture of gas. J. M. Rose.

429,054.—Combined red pigment and paint base. J. P. Perkins.

Consists of an intimate mixture of ferric oxide and separated or precipitated silica.

429,055.—Process of treating slag for the production of red pigments J. P. Perkins.

Silicious ferruginous slag is pulverized, treated with sulphuric acid and heated.

429,056.—Process of treating slag for the production of red pigments. J. P. Perkins.

Pulverized silicious ferruginous slag is heated with access of air, treated with sulphuric acid, and again heated.

429,097.—Process of manufacturing and bleaching pulp. C. Ramsey.

Issued June 3d, 1890.

429,112.—Filter. J. A. Bowden.

429,117.—Paving compound. D. C. Cregier.

Consists of coal tar, asphalt, metallic ore, sal-ammoniac, cement and lime.

429,124.—Apparatus for manufacturing malt. C. Fey.

429,131.—Process of printing calico. J. J. Hart.

The process consists, first in subjecting the fabric containing the lake or fixed color to a solution of developing reagent at a temperature below the point necessary to effect the chemical reaction between the lake or fixed color and the developing reagent, and then exposing the fabric containing the fixed color or lake and developing reagent to the action of heat to effect the chemical reaction.

429,157.—Antifriction alloy. S. Singley.

Consists of lead, antimony, tin, bismuth and silver.

429,158.—Antifriction alloy. S. Singley.

Consists of lead, antimony, tin, bismuth and aluminium.

429,161.—Washing compound. C. E. Starr.

Consists of oil of citronella, oleine laundry soap, alcohol, mineral oil, and water.

429,225.—Process of treating slag. St. G. T. C. Bryan.

429,226.—Method of treating slag. St. G. T. C. Bryan.

429,248.—Antifriction composition. S. Singley.

Consists of lead, antimony, tin, bismuth and graphite.

429,249.—Antifriction alloy. S. Singley.

Consists of lead, from 200–400 parts; antimony, 40–80 parts; tin, 15–30 parts, and bismuth, $\frac{5}{8}$–$1\frac{1}{4}$ parts.

429,271.—Apparatus for measuring and carbureting air or gas. F. H. Hambleton.

429,309.—Apparatus for the manufacture of gas. M. S. Greenough, E. C. Jones and W. R. Addicks.

429,313.—Gas meter. B. P. Moors.

429,340.—Oil filtering apparatus. J. Dooner.

429,350.—Red dye. G. Keorner.

The diazo dye stuff which results from the combination of two molecules of naphthionic acid with one molecule of the texrazo-derivative obtained by the action of nitrous acid on orthometatolidine, and which is

characterized by the following properties: it is a reddish brown powder easily soluble in hot water, slightly less soluble in cold, soluble in alcohol with a more yellowish color than in water, insoluble in benzine; an aqueous solution (one one thousandth) upon treatment with an equal volume of acetic acid (thirty per cent.) yields a purple solution, and after standing a precipitate of the same color; hydrochloric acid (twenty-five per cent.) gives at once a blue precipitate from the same solution, and the dye stuff dyes cotton in the alkaline bath without a mordant a brilliant red color, with a slight yellow shade.

429,386.—Process of separating metallic impurities from graphite. M. W. Parrish.

429,398.—Regenerative gas burner. C. Westphal.

429,414.—Hydrocarbon burner. H. C. Brill.

429,417.—Appartus for recovering soda. H. Burgess.

429,423.—Gas meter. J. W. Culmer.

429,424.—Gas meter. J. W. Culmer.

429,426.—Carbureting apparatus. W. Dawson.

429,435.—Detergent. J. J. Gilbert.

A compound for cleaning marble, etc., consisting of a mixture of muriatic acid, borax, soapstone, alum and sal-ammoniac.

429,459.—Apparatus for decolorizing, filtering, etc., liquids. B. Lavigne.

429,482.—Bottle stopper. W. L. Roorbach and G. W. Tucker.

429,516.—Manufacture of gunpowder. R. v. Freeden.

Gelatinized nitrocellulose, still containing the solvents, is stirred in water or steam, or both, until it is divided into grains. The grains are then removed and dried, and may be finished in the usual manner.

429,522.—Process of manufacturing sulphate of lead pigment. J. B. Hannay.

The process consists of the following successive operations: first, volatilizing suitable lead ore containing sulphur, and at the same time producing combustible gas mingled with the fumes of the mineral; secondly, admitting air to a combustion chamber, so as to effect combustion of the gases, and thereby reheating and oxidizing the fumes; thirdly, forcibly injecting the gaseous products and oxidized fumes through water or acidulated water in a condenser in which the sulphate of lead is deposited, and finally washing and drying the sulphate produced.

429,523.—Apparatus for the manufacture of sulphate of lead pigment. J. B. Hannay.

Issued June 10th, 1890.

429,638.—Process of manufacturing iron and steel. J. Reese.

The process consists in first decarburizing the metal while in a molten condition by subjecting it to the action of an oxidizing agent, and then

treating the decarburized metal with a calcareous agent and oxide of iron while maintained at a temperature above the fusion point of wrought iron.

429,647.—Process of disintegrating fibrous substances. G. M. Rose.

The crushed material is subjected to the action of a solution containing equal parts by weight of calcium oxychloride, potassium hydroxide, ammonium carbonate, and magnesium sulphate, at a temperature of 200° F.

429,659.—Enamel for coating bricks. J. Stiel.

Consists of a mixture of gravel, silicic acid, phosphorite, or analogous minerals, sodium carbonate, potash, cryolite, fluor spar, apatite, and metallic oxides for suitable coloring.

429,675.—Apparatus for generating oil gas. M. C. Burt.

429,682.—Appartus for treating charcoal. R. V. F. de Guinon.

429,692.—Digestor. F. C. Lovejoy.

429,744.—Process of manufacturing iron or steel. A. J. Severance.

The process consists in adding to the metal while in a molten state a compound of borax, ammonium chloride, spathic iron and pumice, or their equivalents.

429,777.—Welding compound. A. J. Severance.

Consists of borax, pumice stone, salt, ammonium chloride, dolomite and spathic iron ore.

429,791.—Renovating fabrics. A. Mautner.

A cloth restoring composition for plush, velvet or other textile fabrics, composed of a solution of casein, ammonia, tartaric acid, alum, soap, gelatin, and an aniline or other dye.

429,826.—Apparatus for aging wines. L. Wagoner.

429,892.—Process of preventing the oxidation and deoxidation of copper when heated. G. W. Cummins.

The copper is heated in the presence of steam.

430,055.—Vulcanizing wood. W. C. Andrews.

Process consists in first placing the wood in a closed receptacle under high pressure of an aeriform fluid at ordinary temperature or without heat sufficient to boil the sap, and then, while retaining pressure, highly heating the contents.

Issued June 17th, 1890.

430,120.—Apparatus for filtering wine. H. B. Fischer and C. H. Fischer.

430,127.—Apparatus for carbonizing vegetable fibres. J. Illingworth.

430,182.—Method of preserving coffee, etc. P. Gassen.

The coffee, etc., is coated with shellac, wax or rosin, or mixtures of these.

430,198.—Apparatus for making chlorine. E. Solvay.

430,199.—Process of recarbonizing steel. A. Spannagel and F. Springorum.

A regulated stream of carbonaceous material is caused to mix with a stream of the molten metal from the ladle before its entrance into the ingot mold.

430,212.—Manufacture of explosives. H. S. Maxim.

The process consists in confining fibrous gun cotton in a receiver, exhausting the air from the same, then introducing vaporized acetone or its equivalent into the exhausted receiver and dissolving the gun cotton and then expelling the dissolved gun cotton by pressure from the receiver.

430,213.—Carburetor. H. Maxim.

430,214.—Recovering solvents from explosives. H. Maxim.

430,250.—Water color paint. G. S. Hodges and J. M. Tracy.

Consists of finely powdered water colors mixed with alcohol, Russian isinglass, gum arabic and glucose.

430,379.—Apparatus for the solution of gold, etc. S. H. Emmens.

430,387.—Apparatus for ozonizing air. J. C. Kennedy.

430,393.—Insecticide and method of making the same. J. M. A. Miller and P. McMaster.

The process of reducing sulphur to solution and of retaining it in solution, which consists in first adding to sulphur in a pulverized condition a solution of sodium chloride and potassium nitrate in water and thoroughly mixing the whole, then allowing the mass to stand until the sulphur is fairly or fully charged with the soda and potassa, then adding caustic soda to the mixture and agitating the mass, and subsequently allowing the whole to stand and cool.

430,468.—Regenerative gas lamp. F. W. Clark.

430,508.—Refractory compound for incandescent gas burners. J. E. Blomen.

Consists of an organic acid and magnesium salts, a mixture of magnesite and grape pomace or other suitable organic material, and magnesium oxide.

430,516.—Process of producing paper pulp from tobacco. H. Endemann.

The process consists in crushing the tobacco, steeping or boiling the crushed tobacco in water, treating the fibrous residue with a solution of aluminium sulphate under heat and pressure, then treating it with an alkaline substance.

430,533.—Process of preparing diazo dyes. C. L. Müller.

The process consists in coupling together the molecules of certain amido-azo compounds by twos, by means of intermediaries, such as phosgene and thiophosgene or carbon bisulphide, in the presence of alkalies and alcohol, and the said amidoazo bodies are paramido-benzene-azo

bodies of the constitution represented by the formula $NH_2 . C_6 H_4 : N : R$, in which the second element (the residue of which is denoted by R in the above formula) is a phenol, phenol-carboxylic acid or phenol-sulphonic acid, or an amido-sulphonic acid of the aromatic series, capable of combining with diazo compounds and forming azo bodies.

430,534.—Red to brown dye. C. L. Müller.

A pink to orange brown dye stuff, which is a sodium salt of an acid, which has the chemical constitution represented by the formula:

$$CO\begin{cases} N<\begin{matrix}H\\C_6\end{matrix}H_4—N:N—C_{10}H_5(NH_2)SO_3H. \\ N<\begin{matrix}C_6\\10\end{matrix}H_4—N:N—C_{10}H_5(NH_2)SO_3H \end{cases}$$

and which may be regarded as a disazo derivative of symmetrical diamido-diphenylurea, and is characterized by the following properties: It is a brownish red powder, soluble in water, alcohol and sulphuric acid, the aqueous and alcoholic solutions being of an orange red color; from the former, hydrochloric acid throws down a dark bluish purple precipitate, whereas caustic soda produces no change; the sulphuric acid solution is purple red in color, and water throws down from it a purple blue precipitate; it dyes unmordanted cotton from the alkaline or soap both new shades, varying from flesh color to orange brown, according to the proportion of dye stuff used.

430,535.—Yellow dye. C. L. Müller.

It is chemically a sodium salt of an acid, the constitution of which is represented by the formula:

$$CO\begin{cases} N<\begin{matrix}H\\C_6\end{matrix}H_4—N:N—C_6H_3(OH)COOH \\ N<\begin{matrix}C_6\\H\end{matrix}H_4—N:N—C_6H_3(OH)COOH \end{cases}$$

and which is to be regarded as a disazo derivative of symmetrical diamido-diphenylurea, and is characterized by the following properties: It is a dull yellow powder soluble in water, alcohol and sulphuric acid, the aqueous and alcoholic solutions being of a yellow color; from the former hydrochloric acid throws down a dark red brown precipitate, while caustic soda solution turns it an orange yellow color; the sulphuric acid solution is orange red in color, and water throws down from it a brown precipitate, and the dye stuff dyes unmordanted cotton in the boiling alkaline or soap bath a pure yellow color.

430,536.—Process of making butter. D. McGregory.

Consists in removing from yelk of egg the inclosing membrane and tread, agitating or heating the same with fresh milk, and incorporating the mixture with dairy butter until a homogeneous mass is obtained.

430,595.—Apparatus for making paper stock. J. D. Tompkins.

Issued June 24th, 1890.

430,653.—Process of producing plumbates of the alkaline earths. G. Kassner.

Consists in roasting in free air a mixture of lead oxide and the carbonate, hydroxide, or oxide of an alkaline earth. The lead oxide may be replaced by such salts of lead as are reduced to oxides by heat.

430,723.—Regenerative gas lamp. B. Zeitschel.

430,725.—Disinfectant. H. M. Baker.

A slowly dissolving double salt resulting from the combination of alkaline permanganates and silicates.

430,734.—Process of making alkaline carbonates and acetone.

The acetate of the alkaline earth is treated with the sulphate of an alkali, and the resulting alkaline acetate is subjected to distillation.

430,807.—Apparatus for the manufacture of gas. J. A. McCollum and B. F. Burt.

430,812.—Lubricant. J. J. Stock.

Consists of pulverized talc, beef tallow, paraffin oil, potash lye, vermilion red, and oil of myrbane.

430,850.—Cleansing compound. S. V. Harbaugh.

A combination of coal ashes which have been sifted and desiccated with a due proportion of water, salts of tartar, chloride of lime, and carbonate of ammonia.

430,925.—Apparatus for dyeing. C. Corron.

430,958.—Vulcanized plastic compound. W. Kiel.

Consists of crude rubber, sulphur, and mineral oil.

430,959.—Process of manufacturing vulcanized plastic compounds. W. Kiel.

Consists in mixing together sulphur, rubber, and oil, the sulphur being in the proportion of not less than about 80 per cent. of the rubber, by weight, and vulcanizing the compound with an initial temperature of not less than 300°F.

430,975.—Red dye. C. Schraube.

The disulpho acid of the red basic naphthalene coloring matter, called "rosinduline," which has the chemical composition represented by the formula, $C_{28}H_{17}N_3(SO_3H)_2$, and which is characterized by the following properties : It is a red crystaline powder soluble in concentrated sulphuric acid, giving a bright green solution ; it is slightly soluble in cold water, more readily soluble in boiling water ; its alkaline salts are crystalline, and soluble in hot, slightly soluble in cold water ; the sodium and potassium salts crystallize from hot solutions on cooling after the addition of common salt ; the free acid dyes animal fibre a bright red color in the acid bath.

Issued July 1st, 1890.

431,026.—Process of manufacturing red lead. M. Alsberg.

The process consists in incorporating lead nitrate into the material (oxide or carbonate of lead), and exposing the resulting mixture to heat sufficiently high to first drive off any water that may be contained in it, and then to decompose the lead nitrate, thereby furnishing oxygen for the formation of minium.

431,044.—Process of making antimony fluorides. O. O. B. Froelich.

Antimony fluoride and its soluble compounds are prepared by treating a mixture of antimony ore, alkaline nitrates and fluor spar with oil of vitriol, extracting the soluble matter with water, neutralizing the solution with alkalies, and evaporating to crystallization.

431,059.—Carburetor. P. Keller.

431,104.—Protective covering for electric cables. J. H. Cheever.

Consists of rubber, plumbago, asbestus and sulphur.

431,132.—Test tube. J. C. Wharton.

A test tube having a ground or roughened external surface.

431,229.—Filtering apparatus. O. H. Jewell and W. M. Jewell.

431,243.—Obtaining acetic acid and methyl alcohol. F. C. Alkier.

The process of recovering the methyl alcohol and acetic acid from the waste wash water or lye in the manufacture of paper from wood pulp, which consists in concentrating the lye by repeated use, neutralizing by means of an alkali as concentration proceeds, recovering the methyl alcohol from the concentrated solution by distillation, evaporating the residuary liquid to dryness, and obtaining the acetic acid from the acetate by distillation with an acid.

431,268.—Paint. H. Le Bates and E. P. Lawrence.

Consists of a color, and a base composed of a soluble chloride and nitrate, alcohol, molasses and water.

431,297.—Azo color. J. Walter.

Aniline is dissolved in hydrochloric acid and water. When heated to a proper degree sodium nitrite is added. This solution is poured, while stirring, into an alkaline solution of solicylic acid. The whole is then precipitated with an acid and filtered. The dry product of the combination is dissolved in sulphuric acid. Then a mixture of nitric acid and sulphuric acid is added. The liquid thus obtained is poured in water and filtered.

431,386.—Apparatus for distilling oil. T. McGowan.

431,404.—Rosinduline sulpho acid. C. Schraube.

Is a red amorphous powder soluble in concentrated sulphuric acid, giving a bright green solution ; it is readily soluble in cold water and soluble in alcohol and yields amorphous alkaline salts, which are also readily soluble in cold water and cannot be precipitated by common salt. It dyes animal fibre in the acid bath a bright red color.

431,407.—Process of preserving meat, etc. W. Smith.

Meat, etc., is sealed in vessels in sterilized air.

431,426.—Method of making fabrics. J. I. Wood.

The process consists in first, soaking a fibrous material in a bath of rosin soap; second, drying the material; third, subjecting the material while yet damp to a bath of zinc chloride; fourth, passing it over hot rollers; fifth, washing it; sixth, drying it; seventh, coating it with oil; and lastly, passing it between calenders.

431,429.—Manufacture of plates and slabs for building purposes. A. van Berkel.

Consists of burned magnesium carbonate or magnesite, raw paper stuff, peat, sand or other finely divided material, and a solution of fluoric silicate containing vegetable flour.

431,448.—Filter, T. S. E. Dixon.

431,472.—Process of making thiooxydiphenylamine. M. Lange.

A salt of metaoxydiphenylamine is heated with water, sulphur and an alkali or alkaline carbonate, or with a sulphide or polysulphide of alkali. It is a light yellow powder, easily soluble in alkalies, soluble in alcohol and acetic acid, and also, though more difficultly, soluble in alkaline carbonates; insoluble in water and benzene. The solutions are of a yellow color. When heated the substance becomes brown and melts at about 155° C.

431,505.—Making white lead. P. Bronner.

The process consists in converting normal lead sulphate into a basic salt, such as $2\,Pb\,SO_4$, $Pb\,(HO)_2$, or $3\,Pb\,SO_4$, $Pb\,(HO)_2$—by heating it with caustic alkaline lyes, and then heating the basic salt, with a solution of an excess of sodium carbonate.

431,535.—Apparatus for the manufacture of gas. W. J. Taylor.

431,541.—Blue dye. T. Reissig.

Is produced by the condensation of alphanaphthylamine, with the mononitroso compound of diethylmetaamidophenol, and has the following properties: It appears in the form of a dark, crystalline, bronze-like powder, soluble in both alcohol and water with a blue color, the alcohol solution turning red upon the addition of caustic alkali, and becoming decolorized by subsequent heating with zinc dust, but quickly resuming its red color upon the access of air, while the aqueous solution of the coloring matter is precipitated by caustic alkalies, the precipitate consisting of the free coloring base, being soluble in sulphuric ether, with a yellow color and a yellow fluorescence, and it produces upon animal fibres without the aid of a mordant in a neutral or slightly acid bath, and upon vegetable fibres, with the aid of a tannin mordant, bright blue shades, similar to those of methylene blue.

(*Issued July 8th, 1890.*)

431,646.—Composition for the soles of boots or shoes. W. A. Burrows.

Consists of leather flock, water, gelatine and chrome alum.

431,730.—Process of obtaining meat extract. J. Van Ruymbeke.

431,795.—Apparatus for testing the burning qualities of oil. F. W. Arvine.

431,912.—Process of making aluminium. C. Netto.

Cryolite is melted with a flux, and an alkaline metal suddenly introduced.

431,932.—Apparatus for the manufacture of gas. W. T. Bate.

431,937.—Apparatus for extracting oil. H. A. A. Dombrain.

431,985.—Fire extinguishing compound. C. M. Martin.

Consists of sodium chloride, sodium thiosulphate, ammonium chloride, magnesium sulphate, magnesium chloride, calcium oxide and ferric oxide, mixed and dissolved in water.

431,986.—Purifying salt. E. K. Mitting.

The salt recovered from spent soap lye is washed with a saturated solution of salt, to which a small proportion of alkali has been added, and a similar saturated solution containing acid. W. R.